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Precautions for Track Work

THE New York State Railroad Commission has made several recommendations for improved operating conditions on railroads as a result of the Bronx Park derailment on the New York Central and Hudson River Railroad, that may be of interest and value to officials in charge of maintenance of way in formulating future rules, with special attention to electric trains. This board recommends that all tangents and curves on the main line track in the electric zone shall be equipped with shoulder tie plates, constructed with a shoulder on the outside of each rail, on each tie. This recommendation was deemed of such importance by the officers of the New York Central and Hudson River Company that it is already being complied with. This will necessitate the use of eight spikes on each tie, four on each end to clamp the rail securely to the tie as well as providing for any additional shear that may be set at the base of rail. This of course involves considerable expense, but is a precaution against accidents which may occur with electric locomotives having a low center of gravity. It was also recommended that it would be to the best interests of the public and to the railroads if the rules required a consultation between the persons charged with maintenance of way and those in charge of making up the train schedule before such schedules were put in effect. In other words, while the head of the railroad company may give directions which if carried out would justify the assumption that the track and roadbed would stand a speed of a certain number of miles per hour, it would seem that safety can be assured and responsibility located only by providing that before each new schedule goes into effect the person charged with the responsibility for the maintenance of the track over which the trains are to run shall certify to those in charge of the schedule that the track is in safe condition for the increased traffic. Many accidents would be avoided in the adoption of such precaution as seems necessary to have an efficient and smooth working organization.

Experience has taught that it is wiser to make modifications before accidents occur, by so clearly defining duties and responsibility that subordinates shall be compelled to report to superiors that things are right and be responsible for their being wrong, rather than tax their ingenuity in explaining how things might have been different.

Rail Fractures

IT would seem, from the number of railroad accidents caused by rail fractures, that something is wrong in the construction of the track or rails used, and to obtain some information regarding this a joint committee of experts representing the American Railway Association and the rail manufacturers has been appointed to investigate the cause of numerous rail fractures as well as settling the controversy between the railroads and rail manufacturers.

The majority of rail fractures are no doubt due to the increased speed attained, as well as the increased size of motive power and rolling stock, and the track structure

not receiving sufficient reinforcement, such as heavier rails and ballast to meet additional demands. On many roads as fast as the rails can be obtained from the manufacturers and the labor to place them, the heavier rails are put in use, and naturally through this transformation period rail failures are prominent. It is not unreasonable to expect failures when placing new rails on old roadbeds containing new and old ties with poor surface and improper tamping under ties.

A few years ago the heaviest rails in use were 60 and 70 pounds to the yard and at present the 90 and 100 pound rails seem to be inadequate for traffic. This inadequacy has resulted in the thought of increasing the rails to 110 pounds as well as obtaining rails manufactured by different processes.

The mill manufacturers, in some cases, to keep pace with the demands made upon them for rails, have reduced the cropping of the ingot to as low as 8 to 10 per cent, removing only the extreme end of the ingot. For example an ingot measuring 19x19x48 inches long, if cropped 30 per cent would make three 80-pound rails; but with a cropping of only 7 or 8 per cent the same ingot would produce four 80-pound rails.

It is claimed by engineers that the extra rail is not reliable both on account of the segregated condition of the constituents contained in the upper part of the ingot, and during rolling the "pipe," a small longitudinal fracture that is formed in the ingot during contraction, is included in the rail. In reply to this the manufacturers claim that while they cannot produce quite so good a rail from the upper part of the ingot they can still produce a sufficiently good rail for practical purposes. The manufacturers claim the rails do not fail at the "pipe," while the railroad engineers take exception to this and have in many cases demonstrated their belief.

As the results obtained from new rails are not as satisfactory as seems to have been expected there apparently is some controversy between the railroads and the rail manufacturers; the railroads claiming the rails are not up to specification, with particular mention that the limit of phosphorus was exceeded; while the rail manufacturers claim the rails are as ordered and that railroads are using too light rails for traffic. It is the intention as a part of the duties of the above mentioned committee to adjust these differences if possible.

To provide a more durable rail for the increased traffic both in speed and weight of rolling stock, a movement is started toward the adoption of rails made from open hearth steel in place of those commonly made by the Bessemer process. In propagating this movement a large western trunk line has recently placed an order for the delivery of 15,000 tons of open hearth rails per month during 1908. This is the first large order for rails manufactured by the open hearth process and indicates the trend of thought in this connection.

As the low phosphorous ores are somewhat limited the mills manufacturing rails by the Bessemer process are experiencing considerable difficulty in remaining within the phosphorous limit and may be the probable cause of occasionally having rails put in use that do not pass requirements. Phosphorus produces cold shortness, rendering the steel easily broken, especially during the frosty months of the year. This condition points to the early abandonment of Bessemer rails and the use of the more expensive open hearth process.

Going further, some manganese steel rails are being used in special places where the traffic is excessive and renewals are very expensive. One case on the Boston Elevated Railroad where the traffic averages 44,000 tons daily, manganese steel rails were economically placed on a 75 degree curve. As this alignment is exceptional, causing excessive wear, the Bessemer rail showed a wear of 0.78 inches on the ball of the outer rail, in 45 days while the manganese rail showed 0.13 inches wear in 450 days and 0.2 inches in 1000 days.

Owing to the difficulties of casting manganese steel a convenient length for rails is 20 feet and as the web and base must be of larger section than Bessemer rails, the manganese rail is much heavier and more expensive. They are readily bent cold to a radius of 20 feet and cases are known where a radius of 10 feet was accomplished without showing any signs of fracture, thus proving their ductility.

As the impression prevails to some extent that the rail specifications required by railroads are not sufficiently rigid, it may be interesting to know that the specifications commonly required, and standard for The American Railway Engineering and Maintenance of Way Association has been carefully studied by a committee of the above association and at a recent convention this committee did not recommend any changes, which leads to the belief that the specifications commonly required are in accordance with what is considered to be best practice.

Necessities for Good Roadway

THAT more care must be taken to prepare the foundation for roadways cannot be encouraged too strongly, and material of the hardest character and quality should be used. In cases where the surrounding land is of spongy, water-holding clay or quicksand, and material of a hard cast is scarce, the inferior material can be used for roadbed foundation with not less than 3 to 4 feet of solid material placed on top to serve as ballast. Good foundation is essential for a track that will endure a heavy rain without affecting the surface and line, and it has been known where good roadways resting on spongy or water-holding clay would be destroyed by heavy rains. This could have been avoided with a small additional expense at first in constructing a permanent roadbed and which would eventually be repaid in labor necessary to resurface track.

Good practice in building permanent roadbeds is to make width from 20 to 22 feet for single track and from 34 to 35 feet for double track. Wide roadway on a fill is especially desirable to retain ballast and prevent ties from going down the slope while unloading. The labor required to bring up ties and rails that may have rolled down embankments may seem small, but it amounts to considerable, and is sufficient in connection with ballast lost to pay

for the expense of building the additional width of roadway.

To have good permanent tracks it is necessary to have good drainage and either open surface ditches or tile drains, depending on the surroundings, are in accordance with good practice. A four-inch drain tile is minimum used and larger tile is preferable for roadbed and track drainage. Careful drainage of cuts with drain tile will, to a great extent, avoid heaving of track in the winter months, and afford a firmer roadway. Placing drain tile about two feet below the top of surface of the ballast and cover with porous cinders for about one foot, is meeting with general approval. Attention is called to the necessity of keeping all tiling open. Good surface ditches on the top of banks greatly reduce the tendency of material sliding down the embankment and filling lower water ways.

The most durable and one of the best kinds of ballast used is broken or crushed stone, and is in keeping with the continued increase in tonnage and speed of trains, as well as resisting the disintegrating influences of the weather, and if broken in angular pieces when crushed will prevent pulverizing under ties. In crushing stone for ballast the following limits are in accordance with good practice; as a minimum, all stone that will remain on a screen having one-half-inch holes, and as a maximum, all stone that will pass a screen having two-inch holes. Eighteen inches of ballast is commonly used with good results on new roadbed, but where gravel or cinder ballast has already been used on old roadbed, six inches of stone ballast supplied under the ties gives satisfactory results. The desirable feature of stone is the reduction of dust to a minimum, which fact is a source of appreciation by the traveling public, especially through the summer months of the year. Gravel ballast, often accompanied by clay, unless washed and all the fine particles removed, will be more or less dusty, and on the other hand during wet weather it gets soft and mushy, causing bad track surface.

In renewing ties in well settled ballast it is good practice to remove ballast between the ties, then raise track by jack sufficiently to remove decayed tie and replace by putting new tie on ballast ready to receive track and resurfacing. In case only one or two ties need to be removed it is not justifiable to disturb the roadbed, in which case the cheapest way is to dig out the tie and not disturb the remaining roadbed.

In surfacing raise the track to level by jack and tamp under ties until ballast is hard. Sight boards are often used and set at high points in order to remove short sags. Experience has taught that the hardest tamping should be done under the rails, from the outside of tie to within fifteen inches on inside of the rail. Under the center of the tie tamping ought to be about half as hard to eliminate track getting center bound. Tamping picks do good work for light raising on stone ballast and the tamping bar is preferable in gravel.

In order to maintain good track alignment it is essential that the track be in exact gauge and good surface. In giving track final line up the best results are obtained after the raising and tamping of track is finished. The raising and tamping of the track should be so arranged during the day that the track can be properly lined, over the portion surfaced, at the close of the day's work, leaving no irregularities to stand over night.

Terminal Improvements at Huron, Ohio

W. & L. E. R. R.

THE Wheeling and Lake Erie Railroad is making extensive improvements on their dock and yard facilities at Huron, Ohio, such that will enable them to increase the amount of coal and iron ore handled at that point.

These improvements are being made on the yard located at South Huron as well as the dock and harbor near the mouth of the Huron river located at North Huron. In making these improvements it was necessary to change the course of Berlin Road, leading it to the south and crossing over the tracks near the L. S. & M. S. Ry. The average depth of water in the river is shown in Fig. 5 at various places and where it is shallow a dredge has been at work increasing the depth to that required by large freight steamers. The new slip was built by a dredge and all the debris hauled out in the lake to deep water and dumped.

A concrete retaining wall about 300 feet long by 6 feet high shown in Fig. 1 was built on the east bank of the Huron river, where the river is close to the tracks at the south yards to prevent scouring. Additional measures have been taken to guard this point by supporting the outside track, at the endangered point, on trestle work reinforced with lateral stay rods and then filled in with dirt.

The yard at South Huron consists of tracks for the re-

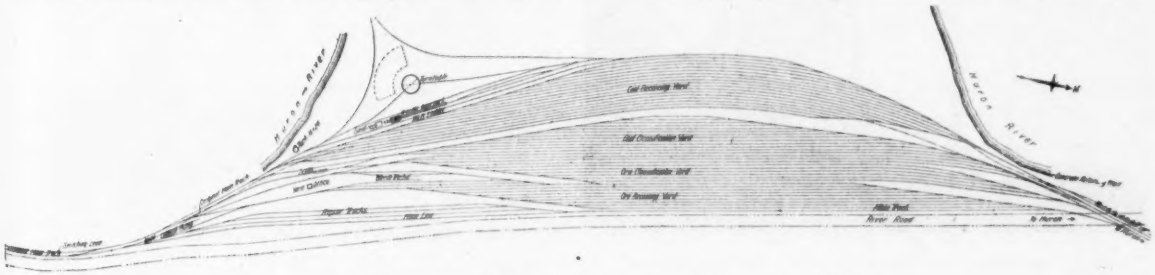


FIG. 1. LAYOUT OF TRACKS IN SOUTH YARD, HURON, OHIO.—W. & L. E. R. R.

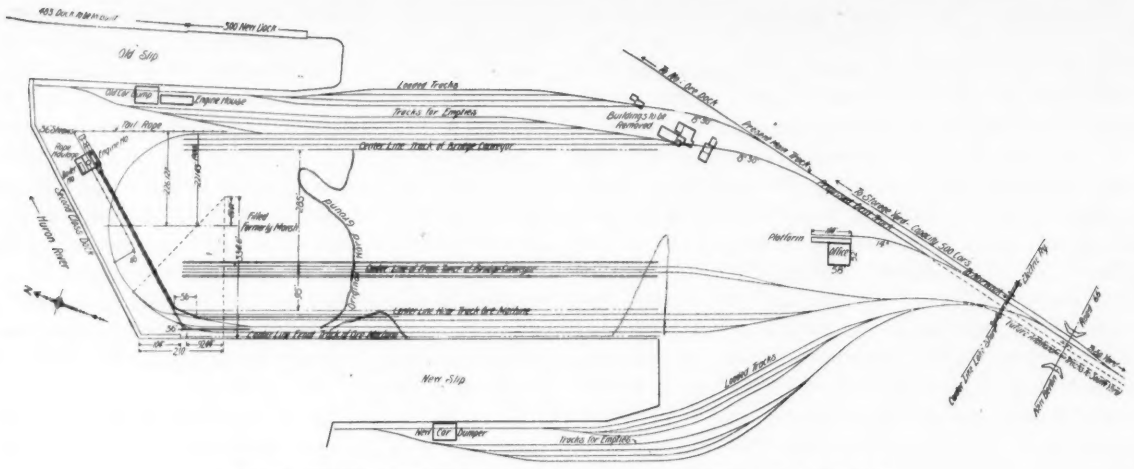


FIG. 2. TRACK LAYOUT ON DOCKS AT NORTH YARD, HURON, OHIO.—W. & L. E. R. R.

ceiving and classification of ore and coal. The main track is at the extreme east displacing the old main that followed the river bank at the south end of the yard. There are three repair tracks at the south end of the yard each about 11,000 ft. long, and 18 feet from center to center. The caboose hump also on the south end is about 2000 ft. long and protected by derail. The turntable, roundhouse and coal plant is conveniently located for both incoming and outgoing engines. Incoming engines after discharging their train pass to the north end of the yard, thence by ladder track on west end back to roundhouse, and similarly for outgoing engines with the exception that they go to the south end instead. A wye is provided around the roundhouse that can be used for turning engines instead of turntable. The common type of cinder pit is used where the cinders are loaded by hand into cars on a depressed track. The pit is located convenient to the coaling plant and its walls are constructed of concrete.

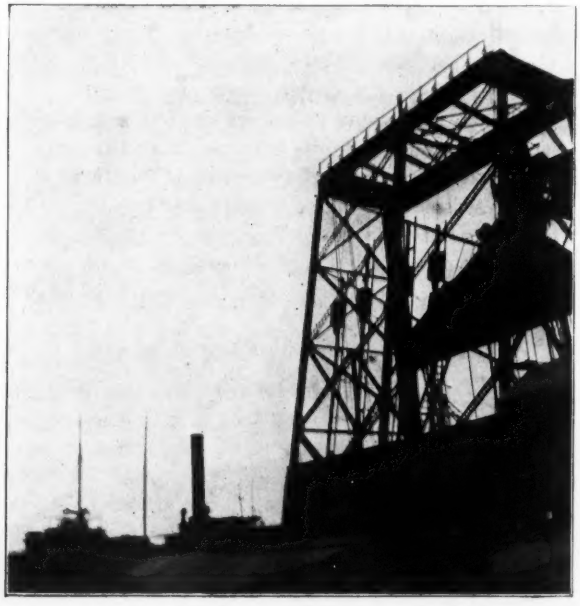


FIG. 3. INCLINED TRACK FOR DISCHARGING EMPTY CARS FROM CAR DUMP, HURON, OHIO.—W. & L. E. R. R.

The coaling plant is of the trestle approach type of 15% grade and is designed to use bottom dump coal cars. Coal is dumped into large bins and from here it is delivered to the locomotives as desired. The sand house is located just south of the coaling plant within convenient access by locomotives. A 16 by 24 foot wooden water tank mounted on cast iron columns and concrete foundations is placed on the south river bank, using river water for locomotives.

On the harbor and dock improvement at North Huron a new McMyler car dump has been placed on the west side of the new slip. Sufficient tracking is provided close to car dump to take care of loaded and empty cars. The empty cars leave the dump onto a declining track and at the bottom of the decline a steep grade is presented giving car impetus to run in the opposite direction. The car in returning, runs onto tracks containing empties by use of a spring switch. As car dump is elevated a little to discharge empties it is necessary to draw loaded cars upon incline by use of cable and power from car dump.

It is intended in the future to build tracks indicated by dasked lines in Fig. 2 to the south yards making a larger gateway between the yards. These tracks, as well as the present main passes under the L. S. & M. S. Ry., the new Berlin road, and the Lake Shore Electric Railway bridges at the point.

The new slip is about 190 feet wide at the center by 1300 feet long, while the old slip is about 130 by 770 feet. About 20 feet of water is found in both slips. The new dock is located between these slips, the majority of which was formerly marsh land. Piles have been driven throughout this marsh land, making same substantial for dock purposes. These piles have been reinforced by iron rods bracing them laterally, and when filled in with dirt afford a substantial structure. The dock has been well cribbed and filled in with stone and other material to the elevation of the surrounding land.

The main dock is equipped with 4 Wellman Seaver Morgan (Hulett) ore conveyors equipped with 5 ton buckets that serve the new slip, 4 clam shell conveyors equipped with 2 ton buckets, 5 clam shell whirlies equipped with 1½-ton buckets, 4 old style whirlies equipped with ton buckets and one McMyler car dump

that serves the old slip. This dock also has a long structural steel storage bridge of 285 feet span that takes ore from small conveyors and carries it back for storage. A general plan and elevation of this bridge will be found in Fig. 7.

The tracks on the east and west side of the main dock are connected by a 26 degree 6 minute curve at the north end and allow empties to be taken direct from car dump on east side and place them for loading ore on the west side. These cars are handled by an endless rope drive arranged as per Fig. 2. A 175 H. P. boiler and engine is to drive this system.

About 800 feet of the dock on the east side of the old slip is to be rebuilt as the old cribbing is not safe for use. The balance of the dock to the north is in fairly good condition and will be rebuilt.

The Hulett five ton ore unloader, illustrated by line drawing in Fig. 6, is used for unloading the ore from the vessel into cars, or placed in storage, and is located along the edge of the dock in close proximity to vessel. There are four in use and operate under their own steam. These unloaders are mounted on four trucks, each containing two pair of wheels at 1 foot 3-⅜ inches gauge placed at each corner. They are also raised to a height of about 16 feet above the top of base rail by two standards spaced 62 feet 10 inches apart to allow clearance for 4 tracks laid side by side to contain cars for loading ore. The tracks upon which the unloader operates is 9 feet 7½ inches above low water level and affords sufficient clearance in case of high water. These tracks are also two feet higher than the surrounding locomotive tracks giving additional clearance for locomotives passing under unloaders. The unloaders are moved lengthwise of dock by positive gear drive to sprockets fixed on forward front trucks. The boom can be raised and lowered as desired through an angle of about 90 degrees. When it is in a horizontal position it projects 60 feet over the vessel. The trolley carrying the bucket travels 50 feet 9¾ inches out on the boom and is sufficient to allow the bucket to drop into the hatchway of any of the largest lake vessels. The total travel of the trolley is 173 feet 11⅞ inches and allows the bucket to be unloaded into cars, on either of the four tracks, or on a storage pile to the rear of unloader. The clearance of the open bucket is 33 feet 11¾ inches above the low water level and is ample to clear all vessels having high decks.

FIG. 4. NEW COAL CAR DUMP, HURON, OHIO.—W. & L. E. R. R.

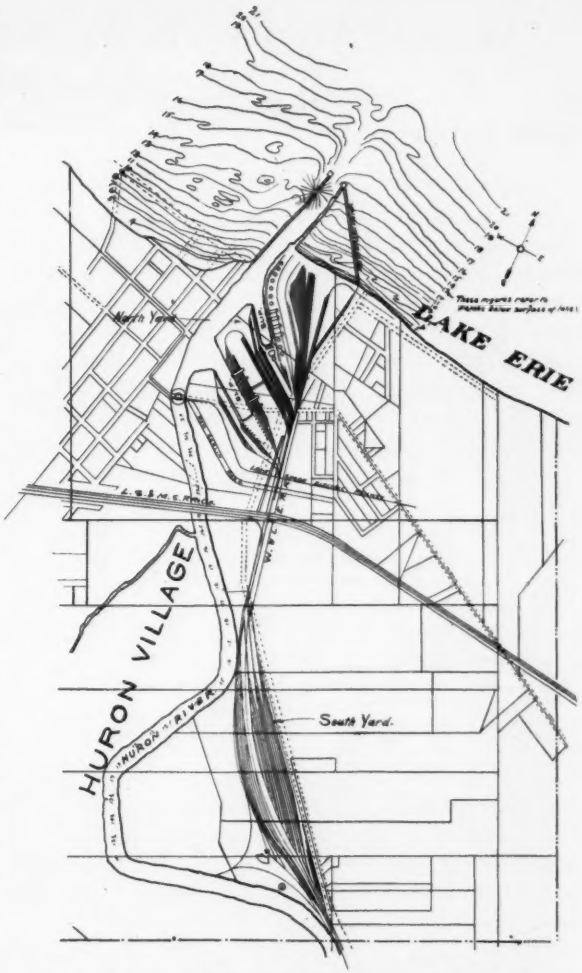


FIG. 5. LOCATION MAP OF HURON, OHIO.—W. & L. E. R. R.

A special designed five ton clam shell bucket is used on each unloader and is operated from tower overlooking boat. Should the ore be stored it is rehandled from pile in the rear of unloader by a large storage bridge, described later in this article, using a ten ton bucket. The entire structure is of structural steel and built for durability. They are comparatively narrow and will allow of two or three unloaders working on the same boat at the same time according to the number of hatchways.

The ore handling bridge is 431 feet 1½ inches long and is used for taking the ore from unloaders and placing it in storage in case the ore is not loaded in cars. This bridge affords a rapid way of disposing of the ore in case of car shortage as well as the ship owners urging immediate discharge of cargo.

A special designed ten ton Hulett clam shell ore bucket is used on the bridge and is twice the capacity of the buckets used on the unloaders. The extreme width of this bucket when open is 15 feet 11 inches and 12 feet 5 inches when closed. The trolley carrying the bucket travels a distance of 396 feet 6 inches in going from one end of the

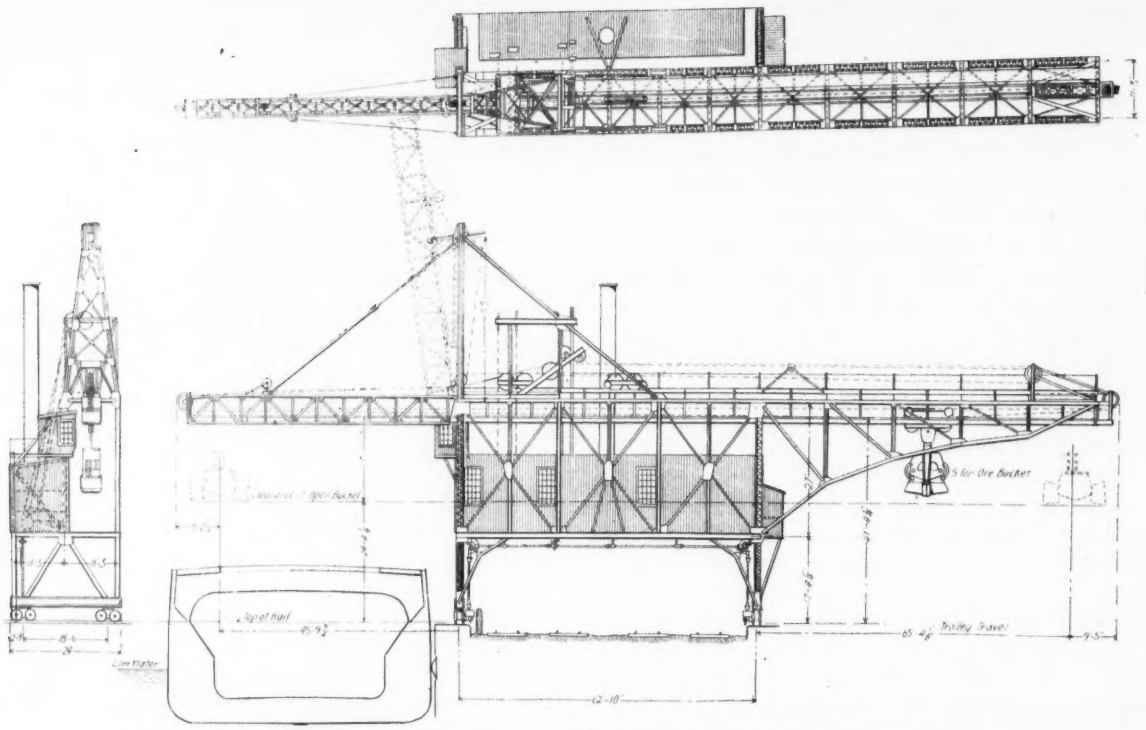


FIG. 6. PLAN AND ELEVATION OF ORE UNLOADER. NEW DOCK EQUIPMENT, HURON, OHIO.—W. & L. E. R. R.

bridge to the other, affording ample space for distributing ore. The bridge is self-propelled, having a power plant built in connection with main support, and may be stopped at any place within the bounds of the bridge track that runs lengthwise of dock. It is 285 feet between supports mounted on trucks placed on three tracks of 2 feet 6 inch gauge. The two tracks carrying the main support, including power plant and machinery, are 32 feet apart. The main support is built upon two standards to a height of about 18 feet from the top of rail to allow clearance for two cars set side by side to receive ore.

The same system of positive drive operates the entire bridge, in its movement over the controlled district, as that used on the unloaders. A system of wire rope controls the operation of the bucket. This as well as the entire bridge machinery is operated from a small tower located just under the bridge mounted on the main support. This height enables the operator to see clearly all the movements required of the bucket.

Seven hundred gross tons per lineal foot of ore can be stored under bridge when deposited in form shown in Figure 7. Having a total length of 1175 feet in which to store ore, the total storage capacity, allowing a slope of 1 to 1, at each end, is about 787,500 gross tons. The ore may be piled to a height of 49 feet 2 inches from the top of base rail to clear bucket when open. The bridge is 71 feet 10 inches high and clears the unloaders at the west and allows 22 feet 8 inches for swing of open bucket.

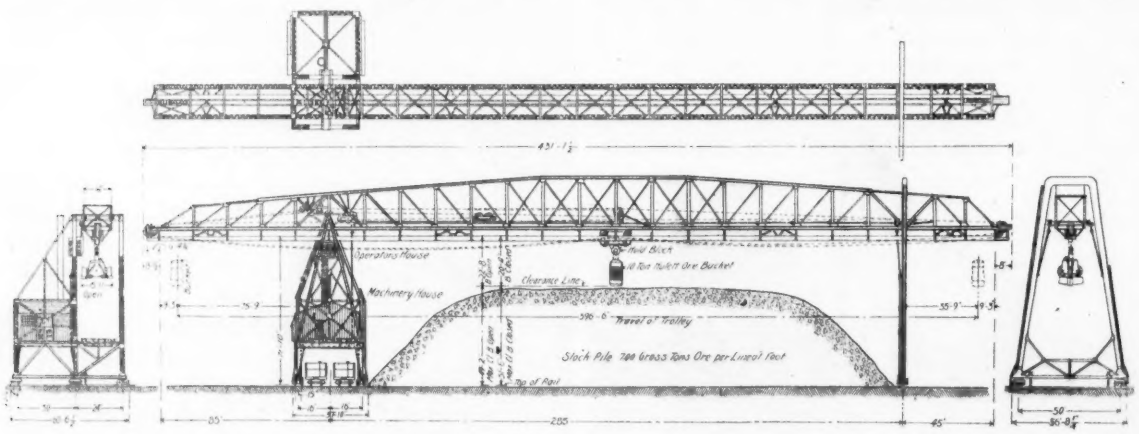


FIG. 7. PLAN AND ELEVATION OF ORE STORAGE BRIDGE. NEW DOCK EQUIPMENT, HURON, OHIO.—W. & L. E. R. R.

Accident Near Woodlawn on the New York Central & Hudson River Railroad.

AMONG the railroad acidents that have occurred in recent years few have evoked such widespread interest and regrettable results as that which happened on February 16 on the New York Central and Hudson River Railroad near Woodlawn bridge. Popular interest in this derailment was greatly increased by the fact that it was an electric train and in consequence much public criticism was directed against this equipment that was recently installed for suburban service in the vicinity of New York.

The electrification of this district is largely due to the accident had in the Park Avenue Tunnel some years ago and it is to be regretted that the success of this innovation should be marred shortly after inauguration.

It seems important that the true relation of the electric motive power to this wreck should be thoroughly known so that no injustice will be done to a means of locomotion that will be of such great benefit to mankind. Any improper public impression that the use of electricity, on trunk line railroads, is attended with new dangers, will disturb confidence in what should be welcomed as a distinct advance in the art of transportation. The fact that the wrecked train was hauled by an electric locomotive at once placed the new motive power under grave suspicion and all kinds of unjust attacks and criticisms have appeared. Much stress is laid upon the "low centre of gravity of the electric locomotive," although this charge is entirely unaccompanied by an analysis of the attendant conditions, such as distribution of weights, method of construction of the pony trucks, etc., which must be taken into account in arriving at a conclusion as to whether or not the centre of gravity had anything to do with the wreck.

The first trial electric locomotive was built by the General Electric and the American Locomotive Companies in accordance with rigid specifications, approved by the Electric Traction Commission, was tested for two and one-half years on a stretch of track six miles long and inferior to that in the New York zone, covering 50,000 miles of actual service at speeds with different weights of train, as high as 84 miles per hour on tangents and 75 miles per hour on curves without a single derailment. The defects as developed during this extended test were carefully studied and necessary corrections made.

It is said by those who rode on the electric locomotive during these tests running at different speeds and around light and sharp curves that its smooth riding qualities was very noticeable over that of the steam locomotive. The thorough and painstaking tests that were made on this new motive power before placing it in service in hauling passenger trains cannot be commended upon too highly.

Recently very elaborate calculations have been made by the engineers of the General Electric, American Locomotive and New York Central and Hudson River Railroad, as well as by Professor Swain of the Massachusetts Institute of Technology, demonstrating the correctness of the conclusions reached as a result of the practical tests above described, as to lack of any undue effect upon the track and also as regards favorable comparison with steam locomotives. These calculations have, of course, taken into account the height of centre of gravity,

PLACE OF ACCIDENT WITH ELECTRICAL EQUIPMENT NEAR WOODLAWN BRIDGE.—N. Y. C. & H. R. R. R.

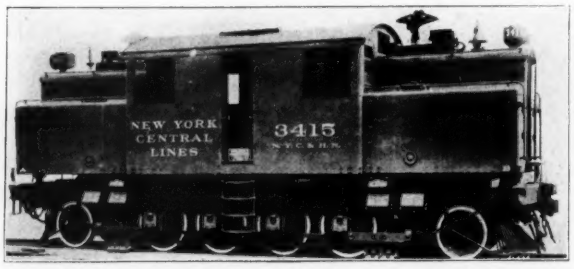
as well as all of the other elements that have to be considered in connection therewith.

It is unfortunate that one of the most potent factors in misleading the public as regards the true cause of this wreck is the evidence by the District Attorney's expert before the Coroner as to the shearing effect on spike; that was based upon an entirely wrong assumption of the construction of the locomotive, having entirely ignored the guiding effect of the pony truck.

The statement has been published "that there is no science of curve mechanics." While this in a general way is correct, it is nevertheless true that the subject has been quite fully discussed by Wellington in "Railway Location" and the essential elements of the problem and methods of calculating indicated. Experimental determination of values for the various constants entering into the problem is a very difficult matter and is the reason for the non-existence of a science of curve mechanics.

A partial analysis of the guiding effect provided on steam locomotives shows that the fundamental elements have been considered and the guiding effect determined therefrom and borne out in practice.

The guiding effect provided for electric locomotives of the New York Central is not only theoretically in accord with what is required, but has the same structure and



TYPE OF ELECTRIC LOCOMOTIVE USED.—N. Y. C. & H. R. R. R.

relation of parts as already provided on steam locomotives and operating successfully.

There might be mentioned three fundamentals of "mechanics of curve resistance":

(1) Component of slipping in the direction of the radius due to curvature.

(2) Component of slipping in the direction of the tangent of track, due to unequal rail lengths inside and outside.

(3) Net effect of centrifugal force (super-elevation of center rail considered).

The locomotive must be revolved against forces Nos. 1 and 2 and such a pressure applied as will cause the locomotive to follow the curve. The point about which the wheel slippage may be determined mathematically for all practical purposes and the stresses resulting from these forces can be easily determined by calculation.

In determining the above, due consideration should be given to the action of the rigid wheel base on the curve in question, taking into account the clearance in the gauge and the clearance between the main drivers and the rigid frame.

It will be appreciated that the radial slip on the front outside driver when rounding the curve is self-contained and of itself does not tend to displace the rail, and that the radial slip on the inside front driver does tend to displace the outer rail, acting through the front axle to the outer front driver.

If the clearance between the driving wheel hubs and the locomotive frame is more than the ordinate of the curve at the second axle, the second axle will run to the outer rail until the flange of outer second driver bears against the rail and thus the frame of the locomotive does not have to carry the radial slippage of the second set of wheels.

The centrifugal effect in case (3) and super-elevation of the outer rail are readily calculated and need no explanation. With the major elements taken into consideration it is entirely possible to practically calculate all of the guiding effect necessary. To solve the problem to the last refinement becomes a complicated and tedious investigation. The slight variation under actual conditions of operation, condition of track, stiffness of parts, etc., introduce constantly changing stresses, which would make a solution to the last refinement of any one given condition of no practical value.

With due consideration to the fundamental and major elements, the problem can easily be solved and the guiding effect determined sufficient for all practical purposes.

Considering first the condition where the second driving axle bears against the locomotive frame and so transmits the radial thrust of the second axle to the outer front driver, a comparison of the New York Central electric locomotive with the Atlantic type steam locomotive on a three degree curve with a 4½ inch super-elevation shows that the pressure of the steam locomotive driver against the rail is greater at all corresponding speeds. The resultant shear on the spikes, however, allowing for the friction of .25 between the rail on the tie plate, is less with the steam locomotive driver than with the electric driver up to about 60 miles per hour.

The difference between the pressure against the rail and the shear on the spikes is affected so far as the drivers are concerned by the height of the center of gravity under the influence of centrifugal force increasing the vertical pressure on the outer rail. The greater effect of the higher center of gravity of the steam locomotive disappears, however, at the higher speeds by reason of the increasing preponderance of the horizontal force due to centrifugal action.

At about 90 miles per hour the shear on the spikes for the steam locomotive would be approximately the same as that of the electric locomotive, but at this speed the steam locomotive would be in danger of overturning.

The maximum shear on the spikes is not necessarily caused, however, by the driving wheels of the locomotive, but at certain speeds may exist at the leading wheel of the guiding truck. Although the pressure of the guiding truck wheel against the rail may be actually less than that of the driver, the weight upon the rail of the guiding wheel is so much less that the resultant shear on the spikes is consequently greater. On the electric loco-

motive the shear on the spikes, due to the guiding truck, is in excess of that due to the drivers up to about 40 miles per hour.

On the steam locomotive the shear on the spikes due to the guiding truck is in excess of that due to the drivers up to about 65 miles per hour, and this shear exceeds that of either the driving or truck wheel of the electric locomotive up to about 57 miles per hour.

Considering (2nd) the condition where the second driving axle clears the locomotive frame by reason of the end play, and so bears directly against the outer rail without transmitting to the leading driver the thrust due to its radial slip.

The pressure against the rail of the leading steam locomotive driver, as in the first condition, is greater at all corresponding speeds. The resultant shear on the spikes is less, however, with the steam locomotive due to the effect of its higher center of gravity.

Under the second condition with the electric locomotive, the shear on the spikes due to the guiding truck is in excess of that due to the drivers up to about 75 miles per hour.

Regarding the stress on the outer spikes of the outside rail, it will be seen from the table annexed that for a speed of, say, 60 miles per hour, on a three decree curve, with a super-elevation of 4½ inches, the maximum shear on the spikes with the forward driver only bearing against the outer rail, is 5,820 pounds, as compared with 4,890 pounds for the steam locomotive, but, on the other hand, if the comparison is made on the basis of the two forward drivers of the electric locomotive bearing against the outer rail, the unbalanced pressure is 2,780 pounds, as compared with 4,890 pounds on the steam locomotive a difference in favor of the electric locomotive of 43 per cent.

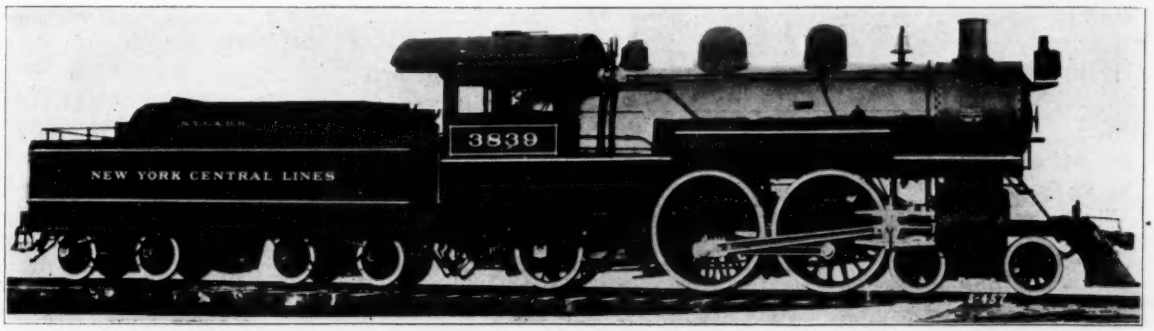
The ultimate shearing resistance of the standard spikes used on the curve in question ranges from 14,440 pounds to 17,000 pounds. Assuming a factor of safety of 4, the permissible shear per spike is 3,810 pounds to 4,265 pounds.

The 100 pound rail in use on the curve acts as a continuous girder distributing the stresses over several spikes, but to be conservative, two spikes may be taken as resisting the unbalanced outward thrust. Consequently at 60 miles per hour we have the actual maximum shears with either steam or electric locomotive ranging from 2,780 pounds to 5,820 pounds borne by two spikes, which, with a factor of safety of 4, are proper for shears of 7,220 pounds to 8,530 pounds. In other words, the actual factor of safety is approximately 6.

It appears that on the basis of the forward driver only bearing against the outer rail, the electric locomotive imposes slightly greater unbalanced stresses than the steam locomotive, whereas, on the basis of the two forward drivers bearing against the outer rail, the steam locomotive imposes considerably greater unbalanced stresses. Therefore the shearing force on spikes, one on the outside of the outer rail in each tie, with tie plates, on three degree curves, properly maintained, with a super-elevation of 4½ inches, is far within the limits of safety for speeds in excess of the so-called "equilibrium speed" of about 46½ miles per hour, to which the super-elevation of 4½ inches corresponds.

Among those asked to take part in this report and whose information is herewith imparted are Professor G. F. Swain of the Massachusetts Institute of Technology, Boston; Professor Mansfield Merriman of New York, and the R. W. Hunt & Co., New York.

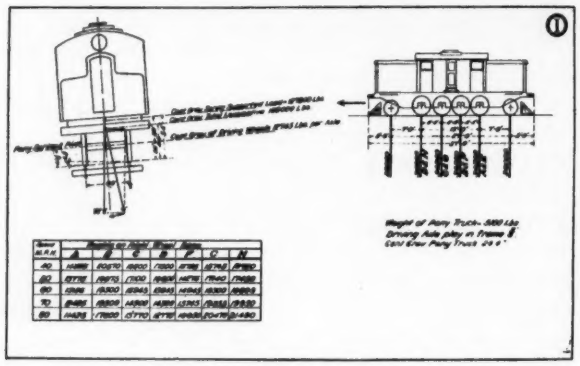
The tables herewith annexed are results of calculations from four set of comparisons, from which it appears that in one instance, with the first driver only bearing against the outer rail, and full allowance made for friction between the rail base and tie plate, the electric locomotive exerts 50 per cent. greater shearing stress on the spikes, with a stress per spike showing a factor of safety of 4; whereas in the other three cases the greatest shearing stress is caused by the steam locomotive with factors of safety ranging from 2½, where the first driver only bears against the outer rail and with no allowance for friction between the rail base and the tie plate, to a factor of safety of 8, where both drivers are assumed to bear against the outer rail and full allowance made for friction between the rail base and the tie plate.



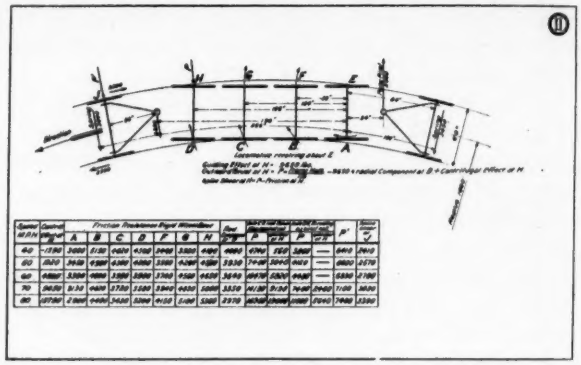
ATLANTIC TYPE LOCOMOTIVE COMPARED WITH ELECTRIC LOCOMOTIVE.—N. Y. C. & H. R. R. R.

From this the conclusion may be drawn that for the worst possible combination that can be assumed, the first driver only bearing against the outer rail and no friction between the rail base and the tie plate, the steam locomotive shows 9 per cent. greater shearing stress with a factor of safety of 2½.

These results are based upon a higher speed around curve than that for which it is elevated, and it would appear that for most of the assumptions the steam locomotive shows greater stress on the outer rail than the electric locomotive, and that in all instances, even at 70



ELECTRIC LOCOMOTIVE.—N. Y. C. & H. R. R. R.



ELECTRIC LOCOMOTIVE.—N. Y. C. & H. R. R. R.

miles per hour on a curve elevated for 46½ miles per hour, the shear on the spikes is well within the limits of safety.

The following table agreed upon by the engineers of the railroad contains a comparison of the shear on spikes at the leading truck wheel, and at driver wheels for electric locomotives and Atlantic type steam locomotive on a 3 degree curve having 4½ inches super-elevation:

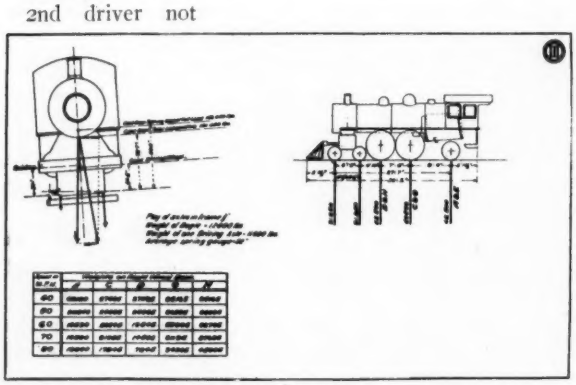
ELECTRIC LOCOMOTIVE.

Speed in miles per hour	40	50	60	70	80
Rail thrust by leading truck wheel, lbs.	6410	6600	6830	7100	7400
Friction between rail and tie plate by leading truck Wheel, lbs.	4000	4030	4050	4080	4100
Shear on spikes by leading truck wheel, lbs.	2410	2570	2780	3020	3300
Rail thrust leading driver, 2nd driver not against rail, lbs.	4740	7400	10470	14130	18360
Rail thrust leading driver 2nd driver against rail, lbs..	3860	4120	4480	7460	11000
Friction between rail and tie-plate under leading driver, lbs.....	4180	4360	4650	5000	5360
Shear on spikes by leading driver, 2nd driver not against rail, lbs.	560	3040	5820	9130	13000
Shear on spikes by leading driver, 2nd driver against rail, lbs.	....	....	.....	2460	5640
Front driver pressure against outer rail, supposing 2nd axle not thrusting against rail, lbs.	4740	7400	10470	14130	18360
Front driver pressure against outer rail, supposing 2nd axle thrusting against rail, lbs.	3860	4120	4480	7460	11000
Guiding truck pressure against outer rail, lbs...	6410	6600	6830	7100	7400

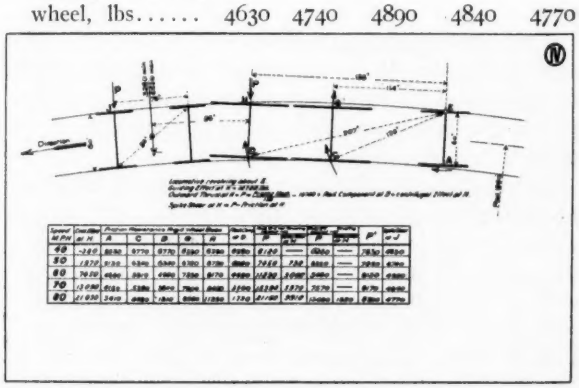
STEAM LOCOMOTIVE.

(Atlantic Type.)

Speed in miles per hour	40	50	60	70	80
Rail thrust by leading truck wheel, lbs.	7830	7950	8130	8170	8200
Friction between rail and tie plate by leading truck wheel, lbs.	3200	3210	3240	3330	3430
Shear on spikes by leading truck, wheel, lbs.....	4630	4740	4890	4840	4770



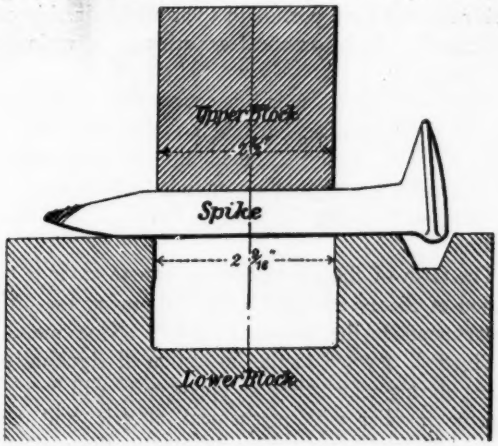
STEAM LOCOMOTIVE, ATLANTIC TYPE—N. Y. C. & H. R. R. R.



STEAM LOCOMOTIVE, ATLANTIC TYPE.—N. Y. C. & H. R. R. R.

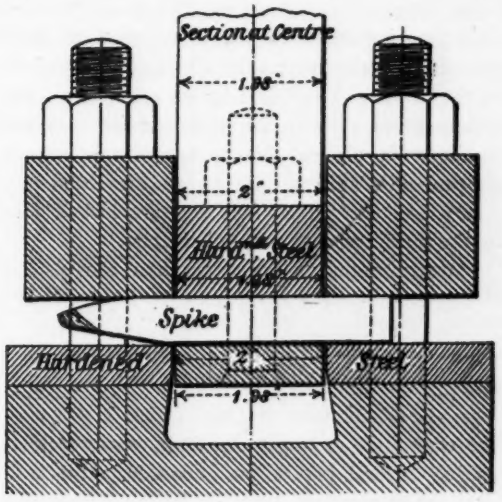
Rail thrust leading driver, 2nd driver not against rail, lbs.	6120	7450	11230	15390	21160
Rail thrust leading driver, 2nd driver against rail, lbs.	6260	6220	5460	7570	13020
Friction between rail and tie-plate under leading driver, lbs.....	6280	6720	8170	9420	11250
Shear on spikes by leading driver, 2nd driver not against rail, lbs.	....	730	3060	5970	9910
Shear on spikes by leading driver, 2nd driver against rail, lbs.	....	....	.....	.....	1820
Front driver pressure against outer rail, supposing 2nd axle not thrusting against rail, lbs.	6120	7450	11230	15390	21160
Front driver pressure against outer rail, supposing 2nd axle thrusting against rail, lbs.	6260	6220	5460	7570	13020
Guiding truck pressure against outer rail, lbs...	7830	7950	8130	8170	8200

Spikes have been tested by different engineers and the following information was obtained from conclusions presented the railroad engineers. Tests in double shear were made by the method illustrated that approaches very closely the actual shearing, bending and tension stresses obtained in actual service where a spike is sheared off by flange of the rail. The elastic limit, or rather the yield point, does not vary more than 2½% from the actual. There was practically no bending of the spike until the elastic limit was reached.



ROUND CORNERED BLOCKS, APPROXIMATING BASE OF RAIL FOR SHEARING SPIKES.—N. Y. C. & H. R. R. R.

The average approximate elastic limit or yield point in either double or single shear is 10566 pounds actual. The average single shearing load of spike is 19740.5 pounds actual. The average single shearing load of spike is 52420 pounds per square inch. These results were obtained in the straight portion of the spike, while in service it would fail nearer the head, where the area would be greater. The area of the spike where tested was



KNIFE EDGED BLOCKS FOR SHEARING SPIKES.—N. Y. C. & H. R. R. R.

.3765 square inches, and the area of the spike at the base of rail, where the shear would probably take place, is about .4225 square inches; therefore the approximate elastic limit and the shearing load at the latter point would be in the proportion of .4225 to .3765 when compared with those actually obtained in the straight portion of the spike.

The approximate elastic limit and the shearing load of the spike at the base of rail would therefore be 11855 and 22145 pounds, respectively.

The knife edged testing block illustrated rigidly clamps the spike so there cannot be any bending of the portion of the spike corresponding to the head and a short length of the shank, as would probably be the case in service. As will be noticed, the elastic limit or yield point is raised when tested in this block and the maximum shearing load is lowered. The results of tests on the latter block follows. The average approximate elastic limit or yield point in either double or single shear is 12625 pounds actual. The average single shearing load of spike is 18753 pounds actual. The average single shearing load of spike is 49807 pounds per square inch. The approximate elastic limit or yield point and the shearing load of the spike at the base of the rail would, therefore, be 14165 and 21062 pounds, respectively.

We have been favored by Mr. W. J. Wilgus, Vice President of the New York Central and Hudson River Railroad Company with report containing photographs and information herewith presented.

Association of Railway Telegraph Superintendents.

THE Twenty-Sixth Annual Convention of the Association of Railway Telegraph Superintendents will be held at the Marlborough-Blenheim, Atlantic City, N. J., June 19th and 20th, 1907.

This convention promises to be of unusual interest in view of the new work and papers to be presented as well as meeting the members of the Railway Master Mechanic and Master Car Builder's Associations, that are to hold their annual convention at Atlantic City about the same time.

Since the formation of the Association of Railway Telegraph Superintendents in Chicago, November 20, 1882, the work accomplished by its committees, for the improvement of railway telegraph service, has been a great factor in placing this branch of railroad service in its present condition. Its growth has been gradual and sure and the annual meetings are looked forward to by the members with unusual interest.

The organization of the association consists of the following committees: Arrangements, Topics, Pole Construction (To Withstand Sleet and Wind Storms), Uniformity of Superintendent's Duties, Legislation for Wire Crossing, and Committee to confer with the American Railway Association as to State Laws.

The committee on topics has been very successful in arranging several papers on important subjects to be read at the convention. A partial list of some of these papers are herewith annexed and judging from the character of the topics to be discussed, the convention will be of more than usual interest:

"Education of Telegraphers in Railroad Work."
By H. C. Hope.

"The Superintendent of Telegraph: What he is versus what he is not."
By T. E. Bentley.

"Maintenance and Operation of Telephone Service on Railroad Company's Lines."
By S. L. Van Akin, Jr.

"Opportunities in the Telegraph Service."
By G. W. Dailey.

"Experiments with Concrete Poles."
By G. A. Cellar.

"Visible Supply of Telegraph Poles."
By W. W. Ashald.

"Operation and Maintenance of Railway Telegraph Service."
By J. C. Browne.

"Wireless Telegraphy."
By Wm. Maver, Jr.

"Standard Telegraph Line Construction."
By C. H. Bristol and D. R. Davies.

Dry Batteries.
By U. J. Fry.

The committee on arrangements has decided not to arrange for any special trips or receptions, and will leave this to the individual. It was thought that some would visit Jamestown or take other trips.

The officers for the years 1906 and 1907 are:

President—E. A. Chenery, Mo. Pac. Ry., St. Louis, Mo.

Vice President—E. P. Griffith, Erie Ry., Jersey City, N. J.

Secretary and Treasurer—P. W. Drew, W. C. Ry., Milwaukee, Wis.

A number of electrical supply concerns always exhibit at this convention and all the new and improved instruments are presented for examination and explanation. This keeps the members in touch with new ideas and in many cases result in their being tried.

The exchanging of ideas and discussion on the merits of new instruments develops mutual benefit as well as leading to the improvement of equipment in use.

Signal Engineering Apprenticeship Course.

THE Union Switch and Signal Co., of Swissvale, Pa., has recently established an apprenticeship course to train young men in railway signaling and the following information may be found in a catalogue recently published, pertaining to the requirements and terms of employment.

Approved applicants will be admitted to the employ of The Union Switch and Signal Company and will be given opportunities to become familiar with the production, installation, maintenance and operation of signals and their operating appliances. The term production includes the design of the apparatus, the experiments conducted to determine the fitness of design, the process of manufacture and the inspection of apparatus before shipment. Installation includes the preparation of such plans, diagrams and other data as relate to the location and installation of signal apparatus, as well as the actual erection of such apparatus in the field. Maintenance includes the safe, reliable and economical care of signal apparatus under service conditions. Operation includes the control of train movement by signals and the definition and meanings of signal indications.

Arrangements have been made with several important railroads by which apprentices will enter the employ of such railroads for a portion of their apprenticeship course and thereby obtain practical experience in maintenance and operation.

Those desiring to enter this course must make application in their own handwriting on the company's prescribed form, giving detailed information concerning their education and past experience and forward to the company at its general offices, Swissvale, Pa., for consideration.

The term of the apprenticeship course extends over a period of three years and is divided among the different departments in the following order: Nine months on production, devoted to the inspection of signaling appliances, during which time an opportunity will be given to become familiar with mechanical, electric and electro-pneumatic appliances. Nine months in the employ of a railroad company devoted to the maintenance and opera-

tion of signal apparatus. Nine months on field installation devoted to the erection of mechanical electric and electro-pneumatic interlocking and block signaling apparatus. Nine months in drafting and engineering, devoted to the design of signal apparatus, the preparation of signaling plans, wiring diagrams, dog and locking sheets and similar work. During this latter period apprentices will be assigned to special work, when the occasion presents itself, in the line of signal engineering as their fitness warrants.

At the option of the company under-graduates in universities or technical schools will be permitted to enter the apprenticeship course during their summer vacations and the time so spent will be deducted from their course. Apprentices are privileged to attend prescribed night classes on subjects pertaining to signal engineering at the expense of the company, provided they attend 75 per cent of such classes while they are located at Swissvale. Otherwise the cost of such classes must be met by the apprentices themselves.

Apprentices will be paid $45.00 per month for the first year; $50.00 per month for the second year and $55.00 per month for the third year. During the time spent in the employ of a railroad company they will be paid not less than $50.00 per month. At the end of their course the company will place apprentices in positions according to their ability as such may become vacant.

The company will pay a gratuity of $300.00 to each apprentice who successfully completes the entire course, and furnish certificate to that effect.

Apprentices will be required to faithfully observe all rules in force and be subject to the orders of the heads of departments or foremen to whom they may be assigned. While in the employ of a railroad company they will be subject to its rules and discipline. The working hours of apprentices will be those of the departments in which they may be employed. The company reserves the right to discharge an apprentice at any time for misbehavior, inattention to duty, or, if in the opinion of the company he is not qualified to pursue successfully the work undertaken.

Magnet for Handling Steel and Iron Freight.

THE Pennsylvania Railroad has recently added a large magnet to their freight handling facilities for transferring steel and iron freight at their terminal yard at Greenville, Jersey City, N. J. This magnet is used in handling metal freight of all sorts, transferring it from car to boat and vice versa.

For years the unloading or loading of freight cars filled particularly with iron or steel was one of the most inconvenient, tedious and comparatively expensive operations of handling freight. It always took large gangs of men who were required to handle each piece separately, with all the attendant delays for argument and remonstrance. The inconvenience of handling pieces of freight under ten tons in weight by hand will readily be seen, as well as the demurrage in holding cars on terminal tracks.

LARGE MAGNET FOR HANDLING STEEL AND IRON FREIGHT AT GREENVILLE TERMINAL, JERSEY CITY, N. J.—PENNSYLVANIA RAILROAD.

Upon rebuilding the terminal yards at Greenville, Jersey City, the Pennsylvania Railroad realized the great importance of obtaining some method for handling their metal freight with greater ease and rapidity at this important terminal. A night and a day force is required to handle the freight both to and from the boats the year around, and any new device that would handle freight more rapidly would pay for itself in labor and demurrage in a comparatively short time. It seems this need became generally known and engineers all over the country were set to work. A Mr. A. C. Eastwood of Cleveland, Ohio,

began experimenting on the electro magnet that later on proved to be a success and was installed at the Greenville terminal.

This device has the appearance of a double crown of corrugated iron and steel and is handled on a crane. The accompanying illustration shows the magnet in use unloading rail onto a boat. The principle of the magnet is similar to the common horse shoe magnet with the exception that the current inducing magnetism is applied from an external source.

A car of metal freight is placed within reach of the crane, the magnet is let down upon it, the current applied by the man controlling the crane and suddenly the metal appears to be alive. Ten ton will adhere to the magnet and will not drop until current is released. The load arranges itself uniformly in the center of the magnet with little effort or noise. All single pieces weighing over ten tons are handled by large traveling cranes that span the eight parallel tracks on the pier. The largest of these cranes has a capacity of 50 tons and can be overloaded fifty per cent with safety. These cranes unload freight direct from cars on any of the eight tracks and deliver aboard a ship lying alongside of the pier.

A recent test made to determine the time saved by the electro magnet versus manual labor, two cars of metal freight were picked out of the same material and weight to make the comparison. It required six men working with unusual rapidity six hours to unload car, while the electro magnet using four men unloaded the other car in one hour. As will be seen a big saving is had in the use of this magnet and others have been ordered.

We are indebted to Mr. G. T. Smith, General Agent, Pennsylvania Railroad, New York, for photograph and information herewith presented.

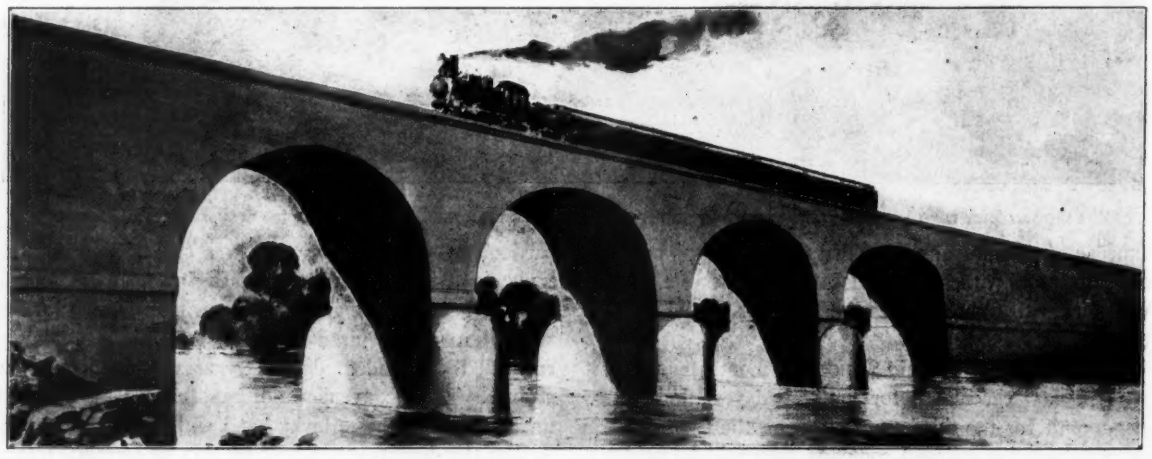
Reinforced Concrete Skew Bridge, near Decatur, Ills.

Wabash Railroad.

THE Wabash Railroad is constructing a reinforced concrete skewed bridge, over the Sangamon river, near Decatur, Ill., that is to replace the bridge used at present, built in 1885. The old bridge consists of a 158 foot iron deck truss; two 116 foot iron deck trusses, and two 40 foot deck plate girder spans.

The new structure will be built of sufficient width to allow of double track and will consist of four arches, each having a clear span of 58 feet 3½ inches, measured at right angles to the side of the pier. The piers are 100 feet from center to center, measured on the center line of the bridge and stand at an angle of 45 degrees. Each pier is founded upon 259 piles driven in a bed of gravel and reinforced with steel rods. They also have flat foundation footings that tend to prevent scouring. At each end of the structure are long hollow abutments, having vertical ribbed walls connected by cross walls, or diaphragms, and carrying a slab floor. A low retaining wall extends from the abutments along the river bank for shore protection. There are no parapet walls, the top of the ties are level with the top of the spandrel walls, but presumably guard rails will be laid across the structure to ensure safety in the care of derailment. The wing walls will be carried to the point of saturation in depth and all exposed edges will have a 3-inch chamfer. These features are shown in the accompanying illustration.

Each arch has a rise of 30 feet from high water mark and is reinforced both longitudinally and transversely by Johnson corrugated bars over the extrados and intrados.



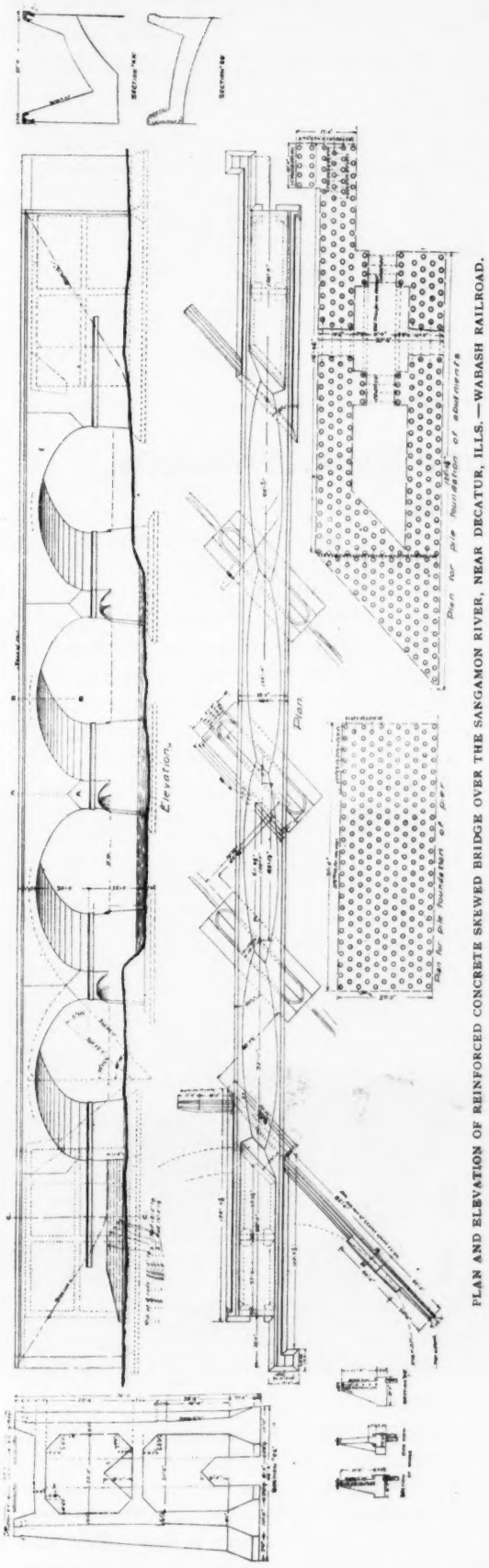
REINFORCED CONCRETE SKEWED BRIDGE OVER THE SANGAMON RIVER, NEAR DECATUR, ILLS.—WABASH RAILROAD.

The spandrel walls also have horizontal reinforced bars.

The concrete used is made of cement, sand and gravel of the following proportions:

Footings for piers	1—2½—5
Piers	1—3 —6
Arches	1—2½—5
Spandrels	1—3 —6
Abutments	1—3 —6
Slabs carrying tracks	1—2½—5
Lower slabs	1—3 —6

The assumed live load for each track is 9000 pounds



PLAN AND ELEVATION OF REINFORCED CONCRETE SKEWED BRIDGE OVER THE SANGAMON RIVER, NEAR DECATUR, ILLS.—WABASH RAILROAD.

per lineal foot and the allowable working unit stress for concrete is 600 pounds per square inch, as well as 12,000 pounds per square inch for steel.

The formulas used for proportioning the steel and concrete were:

$$M = 570\ bd^2 \text{ and}$$

$$g = .132\ h$$

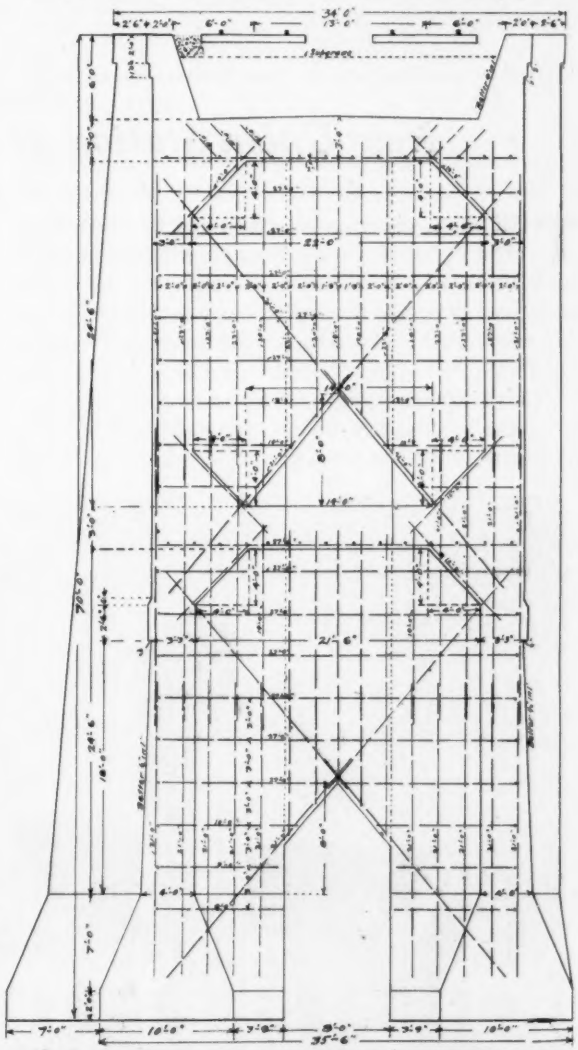
where M = Ultimate moment of cross section in inch pounds.

b = width of beam in inches,

h = the total depth of the beam,

g = area of metal in square inches in width b.

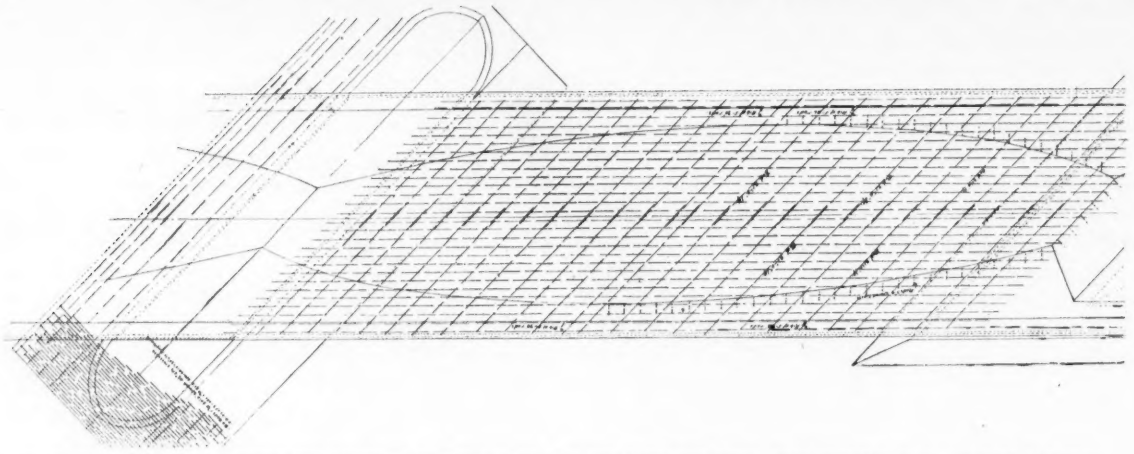
It is estimated this work will cost about $117,000.00



SECTIONAL ELEVATION SHOWING REINFORCEMENT, REINFORCED CONCRETE SKEWED BRIDGE OVER THE SANGAMON RIVER, NEAR DECATUR, ILLS.—WABASH RAILROAD.

and the work is being rushed with all possible speed, by the contractors, Wm. P. Carmichael Co., Williamsport, Ind.

It was commenced in July of last year and is hoped to be completed in the near future. We are indebted to the designer of this bridge, Mr. A. O. Cunningham, Chief Engineer of the Wabash Railroad, for drawing and information herewith presented.



PLAN OF REINFORCEMENT, REINFORCED CONCRETE SKEWED BRIDGE OVER THE SANGAMON RIVER, NEAR DECATUR, ILLS.—WABASH RAILROAD.

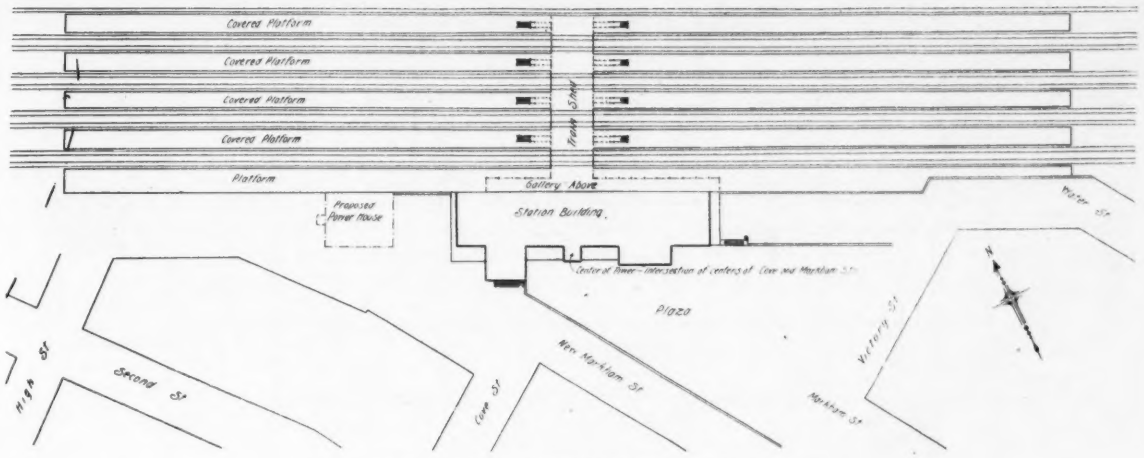
New Union Station at Little Rock, Arkansas.

St. L., I. M. & S. R. R.

THE St. Louis, Iron Mountain and Southern Railroad is building a new passenger station at Little Rock, Arkansas, to replace a wooden structure that is inadequate to handle the traffic. As heretofore, this station will be used jointly by the St. Louis Southwestern and the St. Louis, Iron Mountain & Southern Railroads. This is an important point on the Iron Mountain Railroad, being the headquarters for the operating department of the Southern District as well as the junction point for the branches from Fort Smith, Arkansas, and Alexandria, Louisiana, with the main line.

EVEVATION—LITTLE ROCK UNION STATION

In selecting the type of station to be used the elevated type was chosen as the environment and topographical conditions favored this construction. The basement floor is at the elevation of the track and the main waiting room floor is about eighteen inches above the elevation of the triangular plaza that extends 440 feet along the south side of the station. This plaza also measures 360 feet along New Markham street and 260 feet along Victory street, with which it is level. The station is 315 feet long by 78 feet wide through the center of the building, and is two stories high with basement and attic. As per plan submitted an ell 48 feet long by 23 feet wide will be provided at the east end to be used for buffet. The exterior of the entire building has a five foot base of Batesville stone, with gray pressed brick and Bedford stone trimmings above, and the roof is of red tile with dormer windows. From the central portion of the loggia on the south side there rises a clock tower 120 feet high. The floors are of wood while all supports and



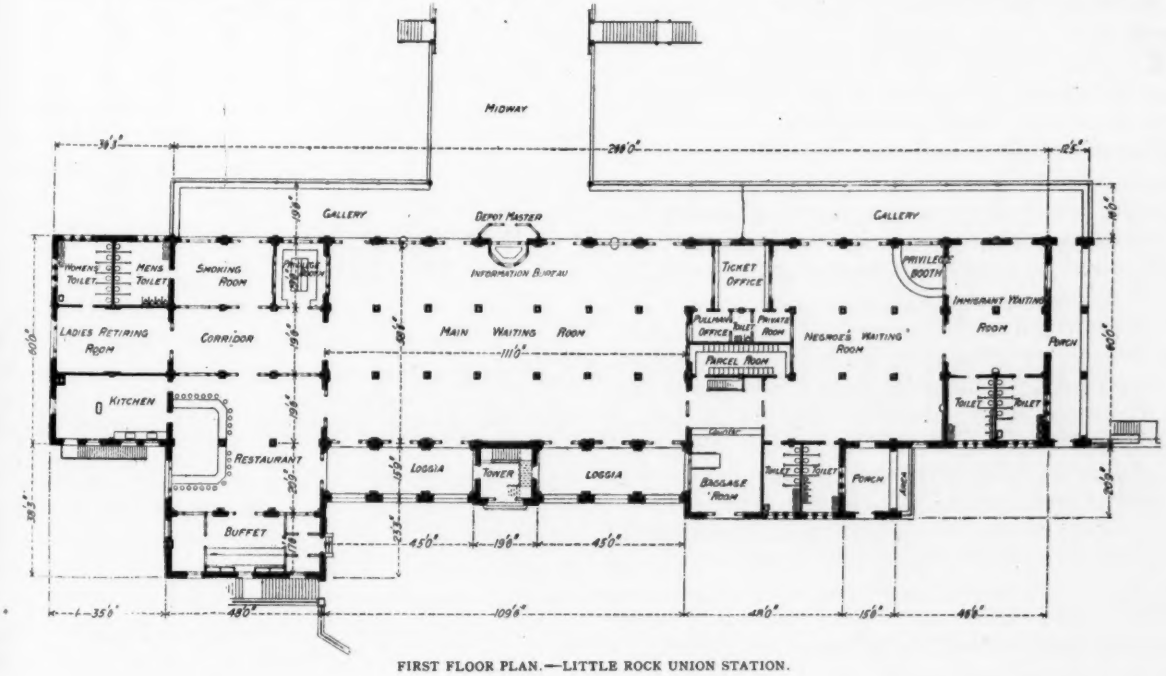
LOCATION PLAN.—LITTLE ROCK UNION STATION.

girders are steel. The first class portion of the first story is to have plastered walls with a marble wainscot five feet high, as well as tile floors and oak woodwork, while the second class parts will have a pine wainscot, pine woodwork and granitoid floors. The entire second story is given up to offices for the various railroad officials and will be finished in oak. The attic will be partly furnished and be used for storage.

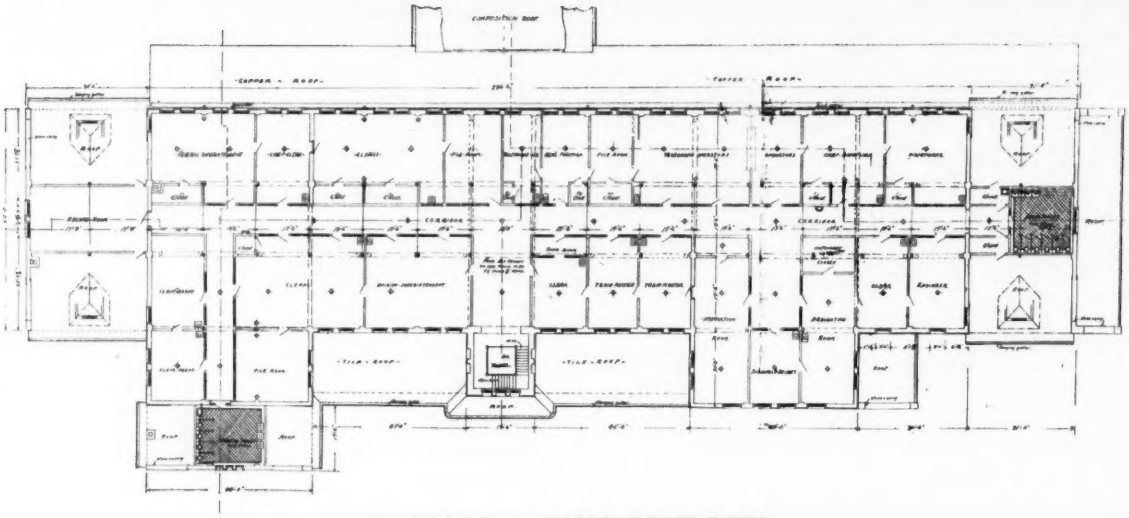
In going to trains from the station the passengers use a covered "midway" bridge built on the same elevation as the main floor, that extends over the tracks and is provided with gateways leading to the different train platforms. These platforms extend 600 feet each way from the center of the "midway" and are parallel with tracks. They are protected from the weather by umbrella sheds.

The basement floor will be occupied by express and baggage rooms, quarters for News Company, store-room and kitchen. The baggage room is at the west end of the station and is entered from the street approaching from the south. The express room is at the east end and is entered from an inclined driveway to the main street.

The main waiting room is 110 feet long by 57 feet wide and occupies the central portion of the main floor. It is entered from the plaza through a loggia 14 feet deep extending along the entire waiting room front. The ladies' retiring and toilet rooms, the men's smoking and toilet rooms, the restaurant and kitchen comprises the west end of the main floor, while the east end is occupied by the ticket offices, parcel check room, receiving room for baggage, negro waiting room, 45 feet by 57 feet, and immigrant waiting room, 32 feet by 57 feet, each having large toilet rooms for both sexes. A down



FIRST FLOOR PLAN.—LITTLE ROCK UNION STATION.



SECOND FLOOR PLAN.—LITTLE ROCK UNION STATION.

chute is to be used in delivering baggage to basement from receiving room on main floor.

A gallery 16 feet wide extends along the entire northerly side of the station and connecting to it is the "midway," in the center of which the station master's office and bureau of information is located. The end of the gallery which serves the negroes and immigrants' waiting rooms, is cut off from the main gallery by a fence, and the ticket office has windows opening into the main waiting room and negroes' room and also to the two sections of the gallery.

We are indebted to Theodore C. Link, architect, St. Louis, Mo., for accompanying illustrations and information.

Railroad Rail Fractures in New York State.

THE New York State Railroad Commission recently issued a bulletin concerning rail fractures on the various railroads of that state as well as some figures. The figures are compiled in form of table showing the total number of rail fractures that occurred on the leading steam railroads in New York State during the winter months, January, February and March of the three last years. The footings show an increase in fractures over last year as presented in the summary annexed, compiled from the commissioner's figures.

The tabulated results show a total breakage of 1,331 in the first three months of 1905, 826 in the same period of 1906 and 3,014 in the first three months of this year.

The figures when reduced to breakages per mile of main track, including all trackage except sidings and yards, are no doubt more expressive and enable one to arrive at closer conclusions. The table indicates for the three winter months of 1905 an average of one break for every seven miles of the 9,474 miles of main track, but in 1907 it was one break in every three miles of track, more than doubling those in 1905. As this increase of failures indicates faulty construction or the use of inferior rails it would seem pertinent that this matter receive prompt attention, as well as steps taken in precaution.

For example, take the main line of the New York Central and Hudson River Railroad between New York and Albany, a distance of 140 miles, equipped with double and triple-track and applying the same failure rate had in 1907 would mean about one rail fracture every 24 hours.

Tables I and II reproduced herewith are classified to-

SUMMARY OF RAIL FRACTURES ON PRINCIPAL STEAM RAILWAYS OF NEW YORK STATE FOR JAN., FEB. AND MARCH, 1905-1906-1907.

Name of Railway.	*Miles main track in New York.	1905 Number of fractures.	1905 Number per mile of main track.	1906 Number of fractures.	1906 Number per mile of main track.	1907 Number of fractures.	1907 Number per mile of main track.
Del. & Hud..	857	60	.07	60	.07	93	.11
Lehigh Vall..	807	125	.15	50	.06	103	.13
Rutland	171	10	.06	7	.04	20	.12
N.Y., N.H.&H.	160	10	.03	2	.01	29	1.8
B. & M.....	146	34	.23	7	.05	5	.03
B. R. & P...	203	27	.13	4	.02	256	1.32
N. Y., O.&W.	526	No record		24	.05	10	.02
Penna.	332	140	.42	186	.56	205	.62
Lake Shore..	158	227	1.44	34	.22	505	3.24
N.Y. C & H.R.	4,183	469	.16	288	.07	1,244	.30
Erie	1,301	76†	.06	142†	.11	429†	.33
D., L. & W..	630	153	.24	22	.03	115	.18
	9,474	1,331 or 0.14 per mi.	...	826 or 0.09 per mi.	...	3,014 or 0.33 per mi.	...

*Mileage from 1905 Report of State Railroad Commission.
†Incomplete.

tals arranged by the commission. The first classifies the fractures according to size of rail with respect to the weight in pounds per yard. It will be seen the greater number of breaks occurred in the heaviest rails used in the three winter months of 1905 and 1907. This may be explained by either the lighter rails laid earlier may have had all the bad and brittle rails removed before the figures of this comparison were taken or by defective methods in the manufacture of the heavier rails such as finishing rails while too hot or allowing sufficient phosphorus in rail constituents to make rail cold short, etc. The com-

TABLE I.—BROKEN RAILS REMOVED FROM THE TRACKS OF THE PRINCIPAL STEAM RAILROADS IN THE STATE OF NEW YORK. DURING JANUARY, FEBRUARY AND MARCH, 1905—1906—1907. CLASSIFIED BY WEIGHT OF RAIL IN POUNDS PER YARD.

Name of Railway.	Total miles Main Track in New York.	January, February and March, 1905								January, February and March, 1906								January, February and March, 1907							
		50-59	60-69	70-79	80	85	90	100	Total	50-59	60-69	70-79	80	85	90	95	100	Total	50-59	60-69	70-79	80	85	90	95	100	Total
Del. & Hudson	857	.....	.....	.....	60	.....	.....	.....	60	.....	.....	.....	60	.....	.....	.....	.....	60	.....	.....	.....	.....	.....	93	.....	.....	93
Lehigh Valley	807	9	11	2	76	.....	27	.....	125	7	3	2	25	.....	10	.....	.....	50	15	2	3	45	.....	38	.....	.....	103
Rutland	171	.....	.....	2	8	.....	.....	.....	10	.....	.....	3	4	.....	.....	.....	.....	7	11	2	1	6	.....	.....	.....	.....	20
N.Y. N.H. & Harlem	160	.....	.....	10	.....	.....	.....	.....	10	.....	.....	1	.....	.....	.....	.....	1	2	.....	.....	28	.....	.....	.....	.....	1	29
Boston & Maine	146	.....	6	25	.....	3	.....	.....	34	.....	.....	2	.....	5	.....	.....	.....	7	.....	.....	2	.....	3	.....	.....	.....	5
Buff. Roch. & Pitts	203	.....	.....	.....	26	.....	1	.....	27	.....	.....	.....	4	.....	.....	.....	.....	4	.....	.....	.....	13	.....	243	.....	.....	256
N. Y. O. & W.	526	.....	.....	No record	.....	.....	.....	.....	.....	4	3	13	.....	.....	4	.....	.....	24	2	.....	4	.....	.....	4	.....	.....	10
Pennsylvania	332	16	119	3	1	.....	.....	.....	140	4	150	.....	13	19	.....	.....	.....	186	10	111	4	8	72	.....	.....	.....	205
Lake Shore	158	.....	5	.....	222	.....	.....	.....	227	.....	2	.....	16	.....	.....	.....	16	34	.....	.....	4	.....	6	.....	.....	495	505
N. Y. C. & H. R. (incl. West Shore)	4183	.....	34	17	219	.....	.....	199	469	.....	24	1	183	.....	.....	.....	83	288	.....	47	24	374	.....	.....	.....	799	1244
Erie	1301	.....	.....	10	30	.....	36	.....	*76	.....	45	.....	7	.....	90	.....	.....	142*	.....	84	8	38	.....	299	.....	.....	*429
D. L. & W.	630	.....	45	31	77	.....	.....	.....	153	2	4	7	9	.....	.....	.....	.....	22	.....	.....	6	105	.....	4	.....	.....	115
Total	9474	25	220	100	719	4	64	199	1331	17	231	29	324	24	100	4	97	826	38	250	80	595	75	677	4	1295	3014

* Record incomplete.

TABLE II.—BROKEN RAILS OF TABLE I. CLASSIFIED ACCORDING TO DATE OF MANUFACTURE.

	January, February and March, 1905 — Year Rail was Rolled										January, February and March, 1906 — Year Rail was Rolled										January, February and March, 1907 — Year Rail was Rolled								
	1904	1903	1902	1901	1900	95-99	90-94	85 89	Before 1885	Total.	1905	1904	1903	1902	1901	96-00	91-95	86 90	Before 1886	Total.	1906 and 1907	1905	1904	1903	1902	1901	1897 to 1896	1892 to 1891	1887 to 1887	Be-fore	Total
Del. & Hud.	54	6	....	....	....	....	....	....	....	60	....	56	4	....	....	....	....	....	....	60	93	....	....	....	....	....	....	....	....	....	93
Lehigh Vall.	1	8	2	4	16	....	—99—			125	1	....	3	2	4	....	—40—			50	1	2	7	3	10	6	—74—			103
Rutland	....	....	2	2	1	3	2	....	....	10	....	....	....	....	2	2	1	2	....	7	....	....	....	....	....	6	....	1	13	....	20
N.Y.,N.H.&H.	....	....	....	....	....	7	3	....	....	10	....	1	....	....	....	....	....	1	....	2	3	23	....	....	....	....	....	2	1	....	29
Bos. & Maine	....	....	2	....	1	2	6	17	6	34	....	....	....	1	2	3	1	....	....	7	....	1	....	....	....	4	....	....	....	....	5
Buff.,Rh.&Ph.	1	2	2	....	2	19	1	....	....	27	1	....	....	....	....	3	....	....	....	4	239	8	1	....	....	8	5	....	....	256
N. Y. O. & W.					No Record					....	4	....	6	....	4	3	6	1	24	....	....	....	1	2	....	3	2	....	2	10
Pennsylvania	....	....	1	....	22	78	25	3	16	140	3	5	....	11	1	86	17	59	4	186	18	11	19	6	11	107	15	7	11	205
Lake Shore	105	8	....	16	33	60	5	....	....	227	16	1	8	....	4	7	3	....	....	34	176	310	....	....	....	....	6	4	....	....	505
N.Y.C.& H.R.	208	20	29	58	62	91	35	7	10	469	13	77	30	53	22	56	19	13	5	286	165	240	495	60	67	142	27	35	28	1244
Erie	....	....	4	....	16	10	29	10	....	76*	3	20	18	19	3	27	3	4	45	142*	156	87	26	4	3	24	24	25	30	429*
D. L. & W.	2	1	17	1	2	18	68	23	21	153	....	1	2	3	1	....	8	1	6	22	4	4	6	9	25	9	54	3	1	115
	371	56	57	81	156	214	179	164	53	1331	37	165	60	95	39	188	55	129	61	826	845	695	555	84	116	310	133	146	130	3014

* Record incomplete.

mission has not attempted to go into the cause of fracture, but the increase for 1907, with its high breakage of 100 pound rail, suggests that the heavier rails are more liable to bad quality.

It is evident from Table II that breaks are more frequent in the first year or two of a rail's service than in subsequent years. The totals indicate that more rails broke before reaching the age of three years than in the following years. Particular attention is called to the large number of failures in the first year.

The claims made by many engineers, that are desirous of increased stringency of specification requirements for steel rails, would seem to be in acordance with results borne out in tabulated table and may have its weight in changing requirements, such as specifying a greater amount of cropping from the upper end of the ingot as well as requiring a more rigid drop test than heretofore.

In case any one or both of these changes are required the product will be considerably stronger and will reduce brittleness to a minimum.

Centrifugal Force on a Railroad Curve Due to the Rotating Parts of a Locomotive.

SHORTLY after the accident on the New York Central and Hudson River Railroad near Woodlawn February 16 last, the officials of that road asked several eminent engineers to make a report in the way of calculations and theory that would throw more light on the cause of the accident.

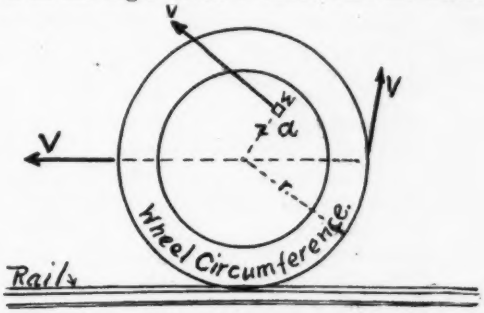
The following information was presented by Mr. Mansfield Merriman of New York and are calculations made on the centrifugal force on a railroad curve due to the rotating parts of a locomotive.

When a body of weight W moves around a curve of radius R with the velocity V, the centrifugal force developed is given by the well known formula:

$$F = \frac{W\,V^2}{g\,R}$$

in which g is the acceleration of gravity. This formula applies when the velocity V along the curve is the same for each of the particles of the body, but it must be modified when some of these particles are revolving. In a steam locomotive the axles, wheels, and rods are revolving about the axes of the axles, while in an electric locomotive the armatures of the motors also revolve about the axes of the axles on which they are mounted.

Consider a revolving mass, symmetrical with respect to its horizontal axis, that axis being vertically above the top of the rail at a distance r which is equal to the radius of the wheel tread. Let the velocity of this axis in the curve of the radius r be called V; then the velocity of the wheel circumference around its axis is also V. Let w be the weight of any element at a distance z from the axis and a be the angle which z makes with the horizontal.



The velocity v with which w moves around its axis is $\frac{z}{r}V$ and the absolute velocity with which w moves around the curve is $V + v \sin. a$ or $V\left(1 + \frac{z}{r}\sin. a\right)$

The centrifugal force developed by the element w is then obtained from formula (1) by replacing W by w and V by $V\left(1 + \frac{z}{r}\sin. a\right)$ Hence the total centrifugal force due to all the parts which rotate around this axis move horizontally with it is

$$F = \frac{V^2}{g\,R} \lesssim w\left(1 + \frac{z}{r}\sin. a\right)^2$$

in which the summation must be extended to cover all values of z and all values of a from 0 to 360 degrees. Expanding and noting that $\lesssim$ w is the weight W that $\lesssim$ w z sin. a is zero and that $\lesssim$ w z^2 sin. ^{2}a is ½ Wk^2 where k is the polar radius of gyration of the revolving mass, there is found

$$F = \frac{W V^2}{g R} + \frac{1}{2}\frac{k^2}{r^2}\frac{W V^2}{g R} \quad (2)$$

as the centrifugal force due to both the horizontal motion of the mass and its motion of revolution around he axis. The first term is the same as (1) and gives the centrifugal force due to the motion along the curve, while the second term gives the additional centrifugal force due to the revolving motion around the axis.

This formula will now be applied to a steam locomotive of the Atlantic type and to an electric locomotive such as is now used on the New York Central and Hudson River Railroad, let W be the total weight of a locomotive, W_1 the weight of all the driving axles and the parts revolving with them, W_2 the weight of the guiding axles and wheels and W_3 the weight of the trailing axles and wheels. Let r_1, r_2 and r_3 be the corresponding radii of the treads of these wheels, and k_1, k_2 and k_3 be the polar radii of gyration of the revolving masses. Then

$$F = \frac{W V^2}{g R}\left[1 + \tfrac{1}{2}\frac{W_1}{W}\left(\frac{k_1}{r_1}\right)^2 + \frac{1}{2}\frac{W_2}{W}\left(\frac{k_2}{r_2}\right)^2 + \frac{1}{2}\frac{W_3}{W}\left(\frac{k_3}{r_3}\right)^2\right] \quad (3)$$

gives the total centrifugal force exerted on the track when the locomotive moves with a velocity V in a curve of radius R.

The following data will be used in order to compare these two types of locomotives. On account of some of the data having been estimated, the numerical conclusions are not exact, but it is believed that they furnish a fair comparison of the relative radial pressures exerted upon a curved track.

SYMBOL	QUANTITY	STEAM LOCOMOTIVE	ELECTRIC LOCOMOTIVE
W	Total weight pounds,	190,000	189,000
	Weight of revolving parts in pounds		
W_1	On driving axles	23,000	46,400
W_2	On guiding axles	7,000	5,000
W_3	On trailing axles	6,000	5,000
	Radius of tread of wheel in inches		
r_1	For driving axles	34.5	22.
r_2	For guiding axles	18.	17.75
r_3	For trailing axles	24.	17.75
	Radius of gyration of revolving parts in inches		
k_1	For driving axles	24.	12.3
k_2	For guiding axles	12.	12.
k_3	For trailing axles	16.	12.

Applying formula (3) to the above data, the following results are obtained:

For the steam locomotive:

$$F = 1.045\,\frac{W V^2}{g R}$$

For the electric locomotive:

$$F = 1.056\,\frac{W V^2}{g R}$$

that is, the rotating parts of the steam locomotive require an addition of 4.5 per cent to the centrifugal force as computed by the common formula (1,) while for the electric locomotive an addition of 5.6 per cent is required.

An analysis of the gyroscopic effect of the problem, indicates that the inclusion of this action would add about 5 per cent to the centrifugal forces. As the calculation of "k" is tedious and as some of the constants entering into the problem are assumed, since we have no experimental data, the small effect due to gyroscopic action of the revolving parts of the locomotives was omitted.

Prices on Track Materials F. O. B. Chicago.

TRACK SUPPLIES.

Steel Rail, 60 lbs. and over	$28.00 per gross ton
Steel Rail, 30 to 45 lbs.	35.00 per gross ton
Steel Rail, 25 lbs.	36.00 per gross ton
Steel Rail, 20 lbs.	37.00 per gross ton
Steel Rail, 16 lbs.	38.00 per gross ton
Steel Rail, 12 lbs.	39.00 per gross ton
Ties, 6x8x8 oak, 1st grade	75 to 77c each
Ties, 6x8x8 oak, 2d grade	65c each
Switch Ties	$30.00 M. ft.

Angle bars, accompanying rail orders, 1907 delivery, 1.65c.; car lots, 1.90c. to 1.95c.; spikes, 2.35 to 2.45c., according to delivery; track bolts, 2.65c. to 2.75c., base, square nuts, and 2.80c. to 2.90c., base, hexagon nuts. The store prices on track supplies range from 0.15c. to 0.20c. above mill prices. Switch set per turn out, $175 to $200.

OLD MATERIAL.

	Per Gr. Ton.
Old Steel Rails, 3 ft. and over	$18.50 to $19.00
Old Steel Rails, less than 3 ft.	18.00 to 18.50
Old Iron Rails	24.50 to 25.00

SHEET STEEL.

It is quoted for future delivery:

Tank Plate, ¼-in. and heavier, wider than 6¼ and up to 100 in. wide, inclusive, car lots, Chicago, 1.86½c. to 2.06½c.; 3-16 in., 1.96½c. to 2.16½c.; Nos. 7 and 8 gauge, 2.01½c. to 2.21½c.; No. 9, 2.11½c. to 2.31½c. Flange quality, in widths up to 100 in., 1.96½c. to 2.06½c., base, for ¼-in. and heavier, with the same advance for lighter weights; Sketch Plates, Tank quality, 1.96c. to 2.16½c.; Flange quality, 2.06½c. Store prices on Plates are as follows: Tank Plate, ¼-in. and heavier, up to 72 in. wide, 2.20c. to 2.30c.; from 72 to 96 in. wide, 2.30c. to 2.40c.; 3-16 in. up to 60 in. wide, 2.30c. to 2.40c.; 72 in. wide, 2.50c. to 2.65c.; No. 8 up to 60 in. wide, 2.35c. to 2.45c.; Flange and Head quality, 0.25c. extra.

STRUCTURAL STEEL SHAPES

Store quotations are unchanged at 2.05c. to 2.10c., and mill prices are as follows: Beams and Channels, 3 to 15-in., inclusive, $1.86½c.; Angles, 3 to 6-in., ¼-in. and heavier, 1.86½c.; larger than 6-in. on one or both legs, 1.96½c; Beams, larger than 15-in., 1.96½c.; Zees, 3-in. and over, 1.86½c.; Tees, 3-in. and over, 1.91½c., in addition to the usual extras for cutting to extra lengths, punching, coping, bending and other shop work.

CAST IRON PIPE.

Quotations per net ton on Water Pipe, 4-in., $38 to

$39; 6 to 12-in., $37 to $38; over 16-in., $36 to $37; with $1 per ton extra for gas pipe.

CEMENT.

	Package.
Good grade Portland Cement, car lots.....	$1.95 in wood 1.55 in paper *1.95 in duck

*(Duck sacks credited when returned.)

SAND.

Bank sand, car lot.....	$ .75 per yd.
Torpedo sand, car lot.....	1.20 per yd.

CRUSHED STONE AND GRAVEL.

Crushed limestone, car lot.....	$1.10 per yd.
Crushed gravel, car lot.....	1.00 per yd.

Personals.

Mr. S. Jordan, roadmaster of the Lake Shore & Michigan Southern at Dunkirk, N. Y., has been transferred to Ashtabula, O., as roadmaster of the Franklin division.

Mr. J. H. Weidman has been appointed assistant engineer of the Michigan division of the Vandalia Railroad at Logansport, Ind., in place of Mr. W. L. Ekin, promoted.

Mr. Richard Schutt has been appointed superintendent of structures of the Northern Railway, with office at San Jose, Costa Rica, and Mr. Oliver Walker has been appointed general roadmaster at that place.

Mr. J. D. Koren has been appointed division engineer of the Northern Pacific at Spokane, Wash., succeeding Mr. A. C. Terrell, transferred.

Mr. George E. MacFarland has been appointed assistant supervisor of signals of the middle division of the Pennsylvania Railroad at Altoona, Pa. Mr. D. B. Bartholomew has been appointed assistant supervisor of signals at Kittanning, Pa., in place of Mr. MacFarland.

Mr. G. B. Owen has been appointed engineer maintenance of way of the Erie at Jersey City, N. J., in place of Mr. James Burke, transferred.

Mr. A. Swartz has been appointed division engineer of the Chicago & Erie at Huntington, Ind., succeeding Mr. A. Crable, transferred.

Mr. B. C. Rich, assistant chief engineer of the Chicago, Indiana & Southern, has been appointed chief engineer, with office at Gibson, Ind. Mr. Byron Layton, engineer maintenance of way, has been appointed signal engineer, with headquarters at Gibson, Ind.

Mr. C. P. Webber, division engineer on the Manzanillo extension of the Mexican Central, has been appointed resident engineer in charge of construction on the Tampico extension.

Mr. E. P. Lupfer has resigned as assistant chief engineer of the Buffalo & Susquehanna and will engage in business as consulting engineer, with office in the Ellicott Square, Buffalo, N. Y.

Mr. R. W. Cattermole, division engineer of the Wisconsin Central at Abbottsford, Wis., has been appointed engineer of maintenance of way, with office at Milwaukee, Wis.

Mr. John F. Stevens, late chief engineer of the Panama Canal, has accepted a temporary position with the New York, New Haven & Hartford, and President Mellen of that road has made the following statement: "Mr. Stevens has consented to supervise some special work for the company prior to accepting any permanent connection elsewhere."

Official announcement is made of the appointment of Mr. R. A. Rutledge as resident engineer of the southern and Galveston divisions of the Gulf, Colorado & Santa Fe at Temple, Tex., in place of Mr. M. T. Pratt, resigned. Mr. C. C. Boyer has been appointed resident engineer of the Beaumont division at Beaumont, Tex., to succeed Mr. Rutledge.

Mr. D. J. Collins has been appointed roadmaster of the Orange & Northwestern at Orange, Tex., succeeding Mr. J. A. Houston, resigned to accept a position with the Dyersburg Northern.

Mr. F. R. Moulton has been appointed superintendent of the Chicago & Northwestern at Huron, S. D., in place of Mr. O. H. McCarty, who has been transferred to Mason City, Ia., succeeding Mr. Moulton.

Mr. H. R. Saunders has been appointed superintendent of the Chicago, Rock Island & Pacific at Little Rock, Ark., to succeed Mr. G. A. Merrill. Mr. J. B. Copley has been appointed superintendent of terminals of the Rock Island at Kansas City, Mo.

Mr. C. M. Scott has been appointed superintendent of the Phoenix & Eastern, with headquarters at Phoenix Ariz.

Mr. H. Flanders, heretofore division superintendent of the Texas & Pacific, has been appointed general superintendent of the Opelousas, Gulf & Northeastern, with headquarters at Opelousas, La.

Mr. William H. Chutt, heretofore chief clerk to the vice-president and general manager of the Minneapolis, St. Paul & Sault Ste. Marie, has been appointed assistant general manager, with headquarters at Minneapolis, Minn.

Mr. J. F. Porter, assistant chief engineer of the Colorado Fuel & Iron Company, has been appointed chief engineer of the Santa Fe, Raton & Eastern, with office at Raton, N. M.

Mr. W. A. Seymour has resigned as resident engineer of the Southern Railway at Knoxville, Tenn., to become chief engineer of railroad construction for the W. J. Oliver Company.

Mr. A. C. Terrell has been appointed division engineer of the Northern Pacific at Spokane, Wash., in charge of engineering matters on operated lines between Ellensburg and Trout Creek, in place of Mr. L. S. Oakes, resigned.

We are advised that the announcement of the appointment of Mr. J. W. Gwyn as chief engineer of the Denver & Rio Grande and Rio Grande Western is without foundation, and that no appointment has yet been made to fill the vacancy caused by the death of Mr. E. J. Yard.

The jurisdiction of Mr. E. A. McFarland, chief engineer, and of Mr. J. C. McClure, engineer maintenance of way, of the Arizona & Colorado, the Maricopa & Phoenix & Salt River Valley and the Gila Valley Globe & North-

ern, has been extended over the Phœnix & Eastern. Headquarters, Tucson, Ariz.

Mr. F. H. Watts, engineer of maintenance of way of the Vandalia at Logansport, Ind., has been transferred to Indianapolis, Ind., as engineer of maintenance of way of the Vincennes division, with supervision over the lines of the Pennsylvania Lines at that point. Mr. Watts is succeeded as engineer of maintenance of way of the Michigan division by Mr. W. L. Ekin.

Mr. W. Bibby, roadmaster of the Grand Trunk at St. Thomas, Ont., has been appointed general roadmaster of the northern division at Allandale, Ont., in place of Mr. P. H. McFadden, resigned to go with the Great Northern. Mr. J. Henderson, roadmaster at Belleville, Ont., has been transferred to Montreal, Que., as general roadmaster of the eastern division, in place of Mr. D. McCooe, resigned to accept service with the Great Northern.

Mr. M. D. Fohey, heretofore trainmaster of the Ann Arbor, has been appointed superintendent of the Mississippi Central, with office at Hattiesburg, Miss.

Mr. Blaine Gavett has been appointed general superintendent of the Kalamazoo Lake Shore & Chicago, with headquarters at South Haven, Mich.

The jurisdiction of Mr. A. T. Dice, general superintendent of the Philadelphia & Reading, and of Mr. W. H. Keffer, superintendent, both with headquarters at Reading, Pa., has been extended over the Williams Valley Railroad.

Mr. W. N. Smith, heretofore secretary, general freight and passenger agent and superintendent of the Ocilla & Valdosta, has been appointed superintendent of the Broxton, Hazlehurst & Savannah, which has purchased the former road. His headquarters are at Fitzgerald, Ga.

Mr. A. W. Johnstone, heretofore assistant division superintendent of the Wisconsin Central at Ironwood, Mich., has been appointed superintendent of the northern division, with office at Abbottsford, Wis., to succeed Mr. A. J. Van Valkenburg, who has been appointed superintendent of transportation, with headquarters at Milwaukee, Wis. Mr. C. M. Winter has been appointed superintendent of the southern division, with office at Fond du Lac, Wis., in place of Mr. A. R. Horn, resigned.

Mr. A. R. Whaley has resigned as superintendent of the New York division of the New York, New Haven & Hartford, to accept a position with the New York Central & Hudson River, and it is stated that he will be general superintendent of the electric division of the latter, succeeding Mr. Ira A. McCormack, who is to be transferred to other duties.

Mr. A. S. Meldrum, heretofore superintendent of the Rio Grande Southern, has been appointed general superintendent, with office at Ridgway, Colo.

Mr. S. L. Dill, heretofore superintendent of the Beaufort division of the Norfolk & Southern, has been appointed general agent of the transportation and traffic departments, with headquarters at New Bern, N. C. Mr. J. R. Hawkins, superintendent of the Bayboro division, has been transferred to New Bern as superintendent of the Beaufort division in place of Mr. Dill. The headquarters of Mr. R. P. Foster, assistant general superintendent, have been removed from Goldsboro, N. C., to New Bern, N. C.

Mr. George Hannauer has been appointed superintendent of the Chicago, Indiana & Southern, with office at Gibson, Ind., to succeed Mr. H. A. Ziesel. Mr. W. L. Connelly has been appointed superintendent of telegraph, with office at Gibson.

Mr. W. R. Hudson, heretofore superintendent of the Spencer-Salisbury terminals of the Southern Railway, has been appointed superintendent of the Danville division, with headquarters at Greensboro, N. C., succeeding Mr. C. S. Lake, resigned.

Mr. C. S. Lake, heretofore superintendent of the Danville division of the Southern Railway, has been appointed superintendent of the Berkshire and Naugatuck divisions of the New York, New Haven & Hartford, with headquarters at New Haven, Conn., succeeding Mr. J. P. Hopson, transferred.

Mr. J. E. Craver, trainmaster of the Northern Pacific at St. Paul, Minn., has been appointed superintendent of the New Fargo division, with headquarters at Fargo, N. D.

Mr. H. P. Greenough, division superintendent of the Chicago, Rock Island & Pacific at Cedar Rapids, Ia., has been transferred in the superintendency of the El Paso division, with headquarters at Dalhart, Tex., succeeding Mr. J. F. Sugrue, resigned. Mr. G. A. Merrill, heretofore superintendent of the Arkansas division, has been appointed superintendent of the Cedar Rapids division, with office at Cedar Rapids, Ia., succeeding Mr. Greenough.

The following changes in the organization of the operating department of the Northern Pacific are announced. Mr. C. M. Levey, now third vice-president, with headquarters at Tacoma, Wash., will be transferred to St. Paul, Minn., in charge of maintenance and operation of the entire system. Mr. H. J. Horn will continue as general manager, with headquarters at St. Paul, Minn., and will have charge of maintenance and operation in Montana, North Dakota, Minnesota and Wisconsin. Mr. H. C. Nutt, heretofore general superintendent of the Michigan Central at Detroit, Mich., will be general manager in charge of maintenance and operation of the lines in Washington, Idaho and Oregon, with office at Tacoma, Wash.

A New Ball Bearing Bridge Jack.

The ball bearing bridge jack herewith illustrated is of 75 tons capacity and is the product of the Buda Foundry and Manufacturing Company, Chicago, who also manufacture a large line of ball bearings as well as ratchets and friction jacks. The especial feature of this jack is the different mechanism made necessary in order to secure the leverage necessary without undue loss of time.

A large spur gear and pinion is combined with a bevel gear and pinion. These gears are all made of forged steel and are machine cut, after which they are case hardened. The balls used in the bearings are of special alloy and will stand 25 per cent greater strain than the ordinary kind. The bronze nut,

through which the screw passes, is made of a special mixture. The jack is of the highest grade in every particular and is perfectly adapted to heavy lifting.

These jacks are thoroughly inspected and tested to about 20 per cent greater load than their rated capacity. The testing is done in hydraulic machines and after the jack has been thoroughly tested a tag certifying to test, with date and load,

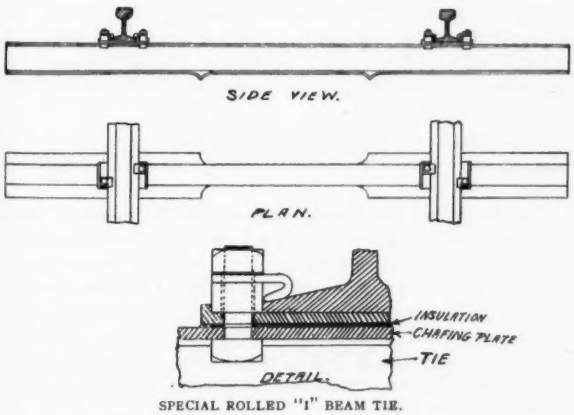
BUDA BRIDGE JACK.

is attached to the jack; thus insuring safety to the user. The Buda Company issued a special jack catalogue that explains fully the workings of this jack as well as others they produce. A copy of this catalogue as well as any information may be had by writing the manufacturers.

Special "I" Beam Tie.

The accompanying design of steel tie has recently been presented for use, and is a special rolled "I"-beam with a wide base and narrow upper flange. The bottom flange is cut away at center of the tie for about two and one-half feet, reducing it to about the same width as the upper. This obviates the probability of the tie becoming anti rocking and center bound. It is well to consider the latter features in connection with steel ties as it is not expected that they be renewed as often as wood.

In shearing metal off the bottom flange the corners are turned down to offer greater lateral resistance in the ballast, thus keeping better track alignment. The wear between the rail and steel tie is considerable, particularly on the lower side of curves, and to prolong the life of the tie a chafing plate is inserted. This



SPECIAL ROLLED "I" BEAM TIE.

plate is a cheap and effective means of taking care of this wear and is preferably made with a shoulder on each side against which the rail clips abut, and transfer the strain to both bolts instead of one. The chafing plate also permits of the use of a narrower upper flange on the tie than ordinarily.

The insulation, illustrated in accompanying line engraving, consists of a fiber plate placed between top flange of tie and chafing plate. The timble extends through the washer and spring and is insulated by a fibre washer on top. The life of the fibre is prolonged by the shoulders on each side of the chafing plate taking care of the compound movement of the rail as well as transferring the strain to the inner bolts.

The spring plate bearing on the bottom flange of the rail may be used instead of a solid clip, to provide for the vertical movement of the rail. The rail should not be held firmly to the tie as it is not only hard on the fastenings but makes the tie conform to the vertical wave movement of the rail, destroying the ballast and tamping.

This tie is reduced in weight about twenty pounds from that of the uniform section, and was patented by Mr. Andrew Morrison, Civil Engineer, Cambria Steel Co., Pittsburg, Pa.

Cup Bar for Reinforcing Concrete.

A special rolled bar for reinforcing concrete is illustrated herewith and is manufactured by making cup shaped impressions in rods of uniform section. These impressions are of such a depth that allow of sufficient concrete to permeate and prevent the possibility of shearing along the line of the bar. The efficiency of a deformed bar depends upon the superficial area for adhesion, mechanical bonds, tensile strength and the consequent economy of metal, and it is indicated from recent tests that adhesion varies at different points of the rods according to the roughness of surface, and the richness or age of the concrete.

The frictional resistance offered to slipping of the steel is due to the setting of concrete. The outer portion hardens first, compressing the concrete around the reinforcement and gripping the steel tightly. This grip is so variable that little reliance can be placed upon it for practical solutions. In any event immediately upon stretching or straining the steel beyond its elastic limit the sectional area of a bar diminishes under elongation and the effect of adhesion is entirely lost. It may be advantageous in such instances to use high carbon steel, but this affords no

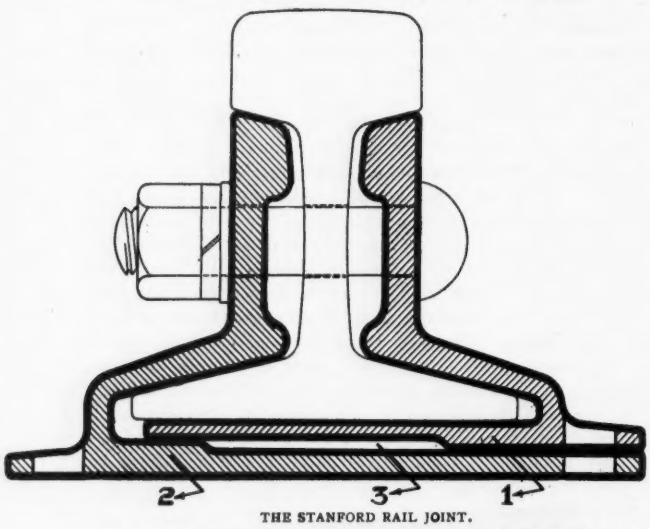
CUP BAR.

assurance that sufficient friction would be obtained to make the reinforcement reliable. Adhesion is modified by the presence of moisture and actual tests have demonstrated that immersion in water for a period of nine months will reduce the adhesion fifty per cent. The mechanical bond depends upon the roughness of surface, opportunity for the proper development of the strength of concrete in shear and the amount of surface offered to resist compression in the concrete at proper angles. The line of resistance to shear in the concrete would connect the tops of the transverse ribbing and develop strength according to their longitudinal distance apart. The line of their base, hence the thickness of the web is purposely made very small and the distance between the ribs correspondingly large in order to develop the strength of the concrete fully. That is to say the shear value of the steel web should be equal to the shear value of the concrete. In other words the ratio of the relative resistance to shear transverse rib is made as slight as it can be practically rolled.

In case of undue strain in reinforced concrete beams vertical cracks may open along the line of the bar and it is desirable that these cracks may be as small as possible. In any case where deformed bars are used the line of shear in the concrete will be along the extreme sectional periphery of the bar. All angular surfaces are practically rounded in rolling so as to eliminate sharp angles and prevent the formation of angular or re-entering cracks during the contraction of the concrete while setting. This bar is marketed by the Trussed Concrete Steel Co., Detroit, Mich., and can be had in any size from ⅜ to 1¼ inches.

The Stanford Rail Joint.

A new rail joint devised by Mr. Arthur L. Stanford, Railway Exchange, Chicago, has recently been put upon the market and the inventor claims the following merits: By referring to accompanying illustration it will be seen that the rail base and splice bar flange 1 are deprived of direct support and their elasticity is utilized by bending nearly to, but not exceeding, the elastic limit thus being protected from injury by the hammering of the car wheels. By means of recess 3 there is no bearing between splice bars 1 and 2 at the central part and similarly utilizing elasticity to nearly its elastic limit and protecting the rail tread from battering. This joint protects and increases the life of the rail as well as reducing noise, rail fractures, damage to rolling stock, and cost of maintenance.



THE STANFORD RAIL JOINT.

The base flanges 1 and 2 overlap and carry the entire weight. They are interlocked by friction and act as one piece. The splice bar flanges are given equal offsets that make each flange stronger near the web. Recess 3 allows of a small center spring that is desirable and when the two bars are unified by friction, a desirable structural shape is provided. The thin wide flanges will adjust themselves to each other and to the rail and a slight variation in thickness is not noticeable. The holding power of the spikes on both sides of the joint is utilized to resist the wheel flange pressure without adding to the tensile strain in the track bolts. The unification by friction of the base flanges tends to lower the neutral axes of the bar. This design is said to have the same advantages as the three piece joint, without their complexity. The cost of this rail joint is nominal and further information may be had by writing the inventor.

Technical Publications.

"Railroad Pocket Book." By Fred H. Colvin. For sale by Derry-Collard Co., 109 Liberty St., New York. Price $1.00.

This handy book is in flexible cloth, 4x6 inches, illustrated and is a combined reference pocket book and dictionary. It is devoted largely to definitions and illustrations of a large number of terms in common and uncommon use in railroad work as well as formulæ for a number of calculations and tables of data in connection with subject defined. It is hard to cover the field upon which this book enters and as stated in the preface it is not complete. The number of subjects already covered is large and if carried further its possibilities are favorable for producing a volume of considerable size. At present the volume contains 217 pages.

"Table of Volumes through Air Ways." By C. D. Kuderer. For sale by E. E. Meyer, Allegheny, Pa. Price 25 cents.

This table of volumes through air ways has been arranged on a sheet of cardboard 8 by 11 inches, as a handy and ready reference for engineers who are handling problems of air transmission through large air ways. Figures are given in tabular form for the flow of air in cubic feet per minute for air ways of various sections and lengths under various rates of flow. An example is given showing the method of calculation.

"Opportunities." By industrial Dept., Rock Island Frisco Lines.

The Industrial Department of the Rock Island-Frisco Lines has issued a 160 page book called "Opportunities," which is calculated to be of great service to any manufacturer or business man in search of another location.

This book contains a concise write-up of each town and city along the 13,500 miles of railroad embraced in the Rock Island, Frisco and Chicago & Eastern Illinois lines, and in parallel columns on the same page with the description of the community, is given a list of the existing openings for business houses, factories, mills and industries of all kinds.

Many new towns and cities have sprung into life along the large number of newly-constructed lines of the Rock Island-Frisco, and particularly in these communities numerous fine openings exist.

Any foundry man, iron-worker or manufacturer of machinery interested in changing his location can secure a copy by addressing M. Schulter, Industrial Commissioner, Rock Island-Frisco Lines, St. Louis, Mo.

"Railway Problems." By William Z. Ripley, Ph.D., Professor of Economics, Harvard University. Published by Ginn & Co., New York and Chicago. Price $2.25; mailing price, $2.40. The book is 5 by 8 inches and contains 686 pages. Professor Ripley has presented in this volume several valuable papers and documents that are of great value to a student of railroad economics. Each paper is supplemented with introductory remarks giving the setting and object of the discussion. Some of the subjects handled in this volume are as follows: A Chapter of Erie, by Charles Francis Adams; Standard Oil Rebates, by Ida M. Tarbell; The Building and Cost of the Union Pacific, by Henry Kerke White; The Southern Railway & Steamship Association, by Henry Hudson, etc. The volume is complete with 27 chapters similar in character to above named subjects that are of exceptional interest and value. The book is indexed complete and affords a wide range of literature useful in understanding the railroad problems of the present day.

This book would be a valuable addition to the library of any one interested in railroad problems and is adapted for use as a text book by students in railroad economics.

The decisions of the Interstate Commerce Commission are of particular value and embrace the important cases that have a large influence in shaping legislation and public opinion as to the things most desired in railroad regulation by the national government.

"Proceedings of the third annual convention of the Maintenance of Way Master Painters" is 7x10½ inches and contains 24 pages.

The papers presented and discussed were as follows: What furnishes the best protection from corrosion on the steel work of a railroad terminal train shed? Conditions that must be met in the ideal paint for railway bridges. Painting Bridges. Linseed oil versus paint as a primer. Drippings of brine from refrigerator cars. Paint as a preservative of structural metal from rust. Painting galvanized iron. The relation of the M. W. painting department to the engineering department by an observer and brushes.

The discussion of the various papers shows earnest efforts on the part of those who took part as well as producing some valuable information. H. J. Schnell, Secretary, 39 Summit St., East Orange, New Jersey.

WANTED—One experienced in Railroad Maintenance of Way to take charge of engineering department in school of Railway Engineering. He will be expected to give instructions on Civil Engineering of railways.

Any one interested address C. E. Care Railway Engineering, Security Bldg., Chicago.